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# QUAIN'S ANATOMY.

# QUAIN'S
# ELEMENTS OF ANATOMY

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IN TWO VOLUMES.

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THIS NINTH EDITION OF

"QUAIN'S ELEMENTS OF ANATOMY"

IS DEDICATED TO THE MEMORY OF

WILLIAM SHARPEY, M.D., LL.D., F.R.S.,

FORMERLY PROFESSOR OF ANATOMY AND PHYSIOLOGY

IN UNIVERSITY COLLEGE, LONDON,

AND DURING THIRTY-FIVE YEARS

ONE OF THE EDITORS OF THE WORK.

# ADVERTISEMENT

## TO THE NINTH EDITION.

THE first four Editions of "Quain's Elements of Anatomy" were the work of the late Dr. Jones Quain; and it has been deemed advisable still to retain the title by which the book has been so long known, notwithstanding that in passing through the succeeding four Editions, and that which now appears, it has undergone alterations so extensive and fundamental that little of the original text now remains.

Of these later Editions, the fifth was brought out under the editorship of Professor Richard Quain and Dr. Sharpey; the sixth was edited by Dr. Sharpey and Professor Ellis; the seventh by Dr. Sharpey and Dr. Allen Thomson, in association with Professor Cleland; and the eighth by Dr. Sharpey, Dr. Thomson, and Mr. Schäfer.

In this Ninth Edition the whole work has been subjected to a thorough revision, and such additions and improvements have been introduced as seemed necessary, without materially altering its form.

In the First Volume, the revision of which has been carried out by Professor Thane, the figures of the Blood-vessels have been coloured, and a Chapter has been added on Superficial and Topographical Anatomy, in the compilation of which the Editor has had the assistance of Mr. R. J. Godlee, M.B., M.S. Lond. In the Second Volume, the revision of the greater part, comprehending the Histology and the Special Anatomy of the Viscera, is the work of

Mr. Schäfer, and the remaining part, or that on Embryology, of Dr. Thomson. Very considerable changes have been made in the departments of Histology, the Central Nervous System, and Embryology. In connection with his part of the work, Mr. Schäfer desires to acknowledge the assistance he has received from the systematic works of Henle, Luschka, W. Krause, and Schwalbe, and from Klein's "Atlas of Histology," and Ranvier's "Traité technique d'histologie." And Dr. Thomson has to acknowledge his obligations to the new edition of Kölliker's "Entwicklungsgeschichte," to His's "Anatomie Menschlicher Embryonen," and to the "Comparative Embryology" of the lamented F. M. Balfour.

A considerable number of new figures have been introduced into the present Edition, some having been substituted for former ones now withdrawn, others added as new illustrations. They are partly from original drawings, and partly electrotype copies of figures in other published works, for their courtesy in allowing copies of which the Editors have to thank the respective Authors and Publishers.

*October*, 1882.

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# ELEMENTS OF ANATOMY.

## INTRODUCTION.

**Object of Anatomy.**—The object of Anatomy, in its most extended sense, is to ascertain and make known the Structure of Organised Bodies. But the science is divided into departments according to its subjects; such as, Human Anatomy, in which, as in the present work, the structure of man forms the principal subject; Comparative Anatomy, comprehending, as a whole or in various subdivisions, the study of the structure of different animals; and Vegetable Anatomy, comprehending the investigation of the structure of plants.

**Organs and Textures.**—On examining the structure of an organised body, we find that it is made up of members or organs, by means of which its functions are executed, such as the root, stem and leaves of a plant, and the heart, brain, stomach and limbs of an animal; and farther, that these organs are themselves made up of certain constituent materials named tissues or textures, such as the cellular, woody, and vascular tissues of the vegetable, or the osseous, muscular, connective, vascular, nervous, and other tissues, which form the animal organs.

Most of the tissues occur in more than one organ, and some of them indeed, as the connective and vascular, in nearly all, so that a multitude of organs, and these greatly diversified, are constructed out of a small number of constituent tissues; and parts of the body, differing widely in form, construction, and uses, may agree in the nature of their component materials. Again, as the same tissue possesses the same essential characters in whatever organ or region it is found, it is obvious that the structure and properties of each tissue may be made the subject of investigation apart from the organs into whose formation it enters.

**General and Descriptive Anatomy.**—The foregoing considerations have led to the subdivision of anatomy into two branches, the one of which, under the name of "General" or "Textural" Anatomy, or "Histology," treats of the minute structure of the component tissues of the body; the other, named "Special" or "Descriptive" Anatomy, treats of its several organs, members, and regions, describing the outward form and internal structure of the parts, their relative situation and mutual connection, and the successive conditions which they present in the progress of their formation or development.

Descriptive Anatomy may be treated of in two methods; viz., the *Systematic* and the *Topographical*.

In the first or Systematic Anatomy, the several organs and parts of the body are considered in a systematic order, according to their structure, their connection with each other, and their relation to the purposes of life; while in the second, or Topographical Anatomy, the parts are described in the order of their position or association in any region of the body. The first method is best adapted for the elementary and complete study of the structure of organs, the second is more immediately useful in the study of particular regions in their relation to medicine and surgery. The object of the present work being mainly to serve as a guide for systematic study, the topographical details will for the most part be included under and combined with the general description of organs, and only some of the more important regions will receive separate notice.

The description of any organ embraces the consideration of its form, size, position, connection and texture; the whole of these constituting the anatomy of the organ. The adult or fully formed condition of the body is commonly assumed as the subject of this description; but it is obvious that a consideration of the structure of the body and its organs in different stages of life is required to render the knowledge of their anatomy complete. To the description of the origin and formation of organs in the embryo, a special chapter will be devoted in this work, under the name of *Embryological Anatomy* or *Fœtal Development*, while the more advanced changes of growth will be described along with the Systematic Anatomy.

The study of anatomy may be viewed in two different aspects; viz., the Physiological and the Morphological. In the former, anatomy supplies the materials relating to structure from which an explanation is sought of the uses or functions of organs by the physiologist; and for this purpose the study of Textural Anatomy is of particular service. In its Morphological aspect, Descriptive Anatomy investigates and combines the facts relating to the structure and relations of organs, from which may be deduced general principles as to the construction of the human body or that of animals. In the determination of these general principles, or laws of Morphology, it is necessary to combine the knowledge of the anatomy of animals with that of man, and both of these with the history of development.

## PLAN OF ORGANIZATION.

**Vertebrate Type.**—The general plan of construction of the human body agrees closely with that which prevails in a certain number of animals, viz., mammals, birds, reptiles, amphibia, and fishes, and is known as the vertebrate type of organisation. The main feature of that type, and that from which its name is derived, belongs to the internal skeleton, and consists in the existence of a number of bones (or cartilaginous substitutes) termed *vertebræ*, which extend in a longitudinal series through the whole trunk of the body, and which by their more solid part, termed *centrum* or *body*, form a pillar or axis, round which the rest of the parts are arranged with a certain similarity of structure. At one extremity of this pillar is situated the *head*, presenting in almost all the animals formed upon this type the character of a greater development of its constituent parts: and at the other the *tail* in which an opposite character or that of diminution prevails: while on the sides of the main part or *trunk*, there project, in relation with some of the vertebral elements, two pairs of symmetrical *limbs*, in two situations which are determinate and similar in different animals.

The head and trunk contain the organs or viscera most important to life, such as the alimentary canal and the great central organs of the sanguiferous and nervous systems, while the limbs, from which such principal organs are absent, are very variable and differ widely in the degree of their development among the various animals formed upon the vertebrate type. The whole body may thus be regarded as being formed of an *axial portion* consisting of the head and trunk, and of *appendicular portions* comprising the limbs. In man and the higher animals the trunk presents a division into the neck, chest, abdomen, and pelvis.

The vertebrate form of skeleton is invariably accompanied by a determinate and conformable disposition of the other most important organs of the body, viz.:—*firstly*, the existence on the dorsal aspect of the vertebral axis of an elongated cavity or canal which contains the brain and spinal cord, or central organs of the nervous system; and *secondly*, the existence on the ventral aspect of the vertebral axis of a larger cavity, the visceral cavity, in which are contained the principal viscera connected with nutrition, such as the alimentary canal, the heart and lungs, the great blood-vessels, and the urinary and genital organs.

The general disposition of the parts of the body and of the more important viscera in their relation to the vertebral axis are shown in the accompanying figures of the external form and longitudinal and transverse sections of the human embryo at an early period of its existence, when its structure resembles more closely that of the lower animals.

Fig. 1.

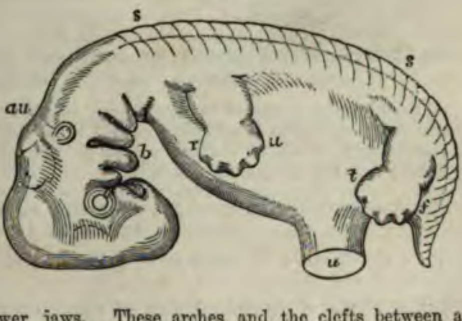


Fig. 1.—LATERAL VIEW OF THE HUMAN EMBRYO ABOUT SEVEN WEEKS OLD; THE VERTEBRAL AXIS PLACED HORIZONTALLY. MAGNIFIED ABOUT 7 DIAMETERS. (A.T.)

*s*, *s*, indications of the vertebral divisions along the line of the back; *r*, *u*, upper limb; *t*, *f*, lower limb; *u*, umbilical opening. In the cranial part the divisions of the brain are indicated, together with the eye, and *au*, the auditory vesicle; near *b*, the visceral arches of the head with the rudiments of the upper and lower jaws. These arches and the clefts between are represented in a state belonging to a somewhat earlier stage than the rest of the body.

**Segmented Character.**—The vertebrate type of organisation presents, therefore, in the repetition of similar structural elements in a longitudinal series, a segmented character, especially in the axial portion of the body, and this segmentation affects more or less, not merely the skeletal parts of its structure, but also, to some extent, its other component organs.

Fig. 2.

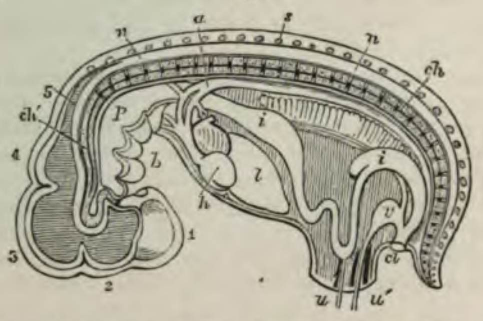


Fig. 2.—Semidiagrammatic view of a longitudinal section of the embryo represented in figure 1; showing the relations of the principal systems and organs to each other in the horizontal position of the vertebral axis. (A. T.)

1, 2, 3, 4, 5, primary divisions of the brain in the cranial part of the neural canal; *n*, *n*, spinal cord in the vertebral part of the canal; *s*, spinous process of one of the vertebræ (4th dorsal); *ch*, chorda dorsalis running through the axis of the vertebral centra; *ch'*, the same extending into the base of the cranium; *a*, dorsal aorta; *p*, pharyngeal cavity; *i*, *i*, alimentary canal; *h*, ventricular part of the heart, from which the arterial bulb is seen joining the aorta by arches; *b*, visceral arches; *l*, liver; *w*, Wolffian body; *v*, urinary vesicle or allantois, joining the intestine in the cloaca, *cl*; *u*, *u'*, umbilicus.

Fig. 3.

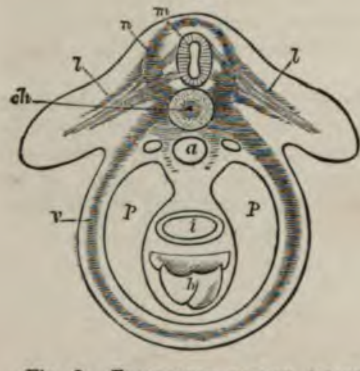


Fig. 4.

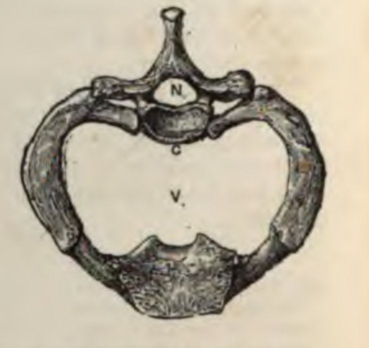


Fig. 3.—Transverse section (diagrammatic) of the trunk of the embryo through the upper limbs. (A. T.)

*m*, spinal cord; *n*, neural or dorsal arch, including bone, muscle, skin, roots of the nerves, &c.; *ch*, chorda dorsalis, surrounded by the vertebral body or centrum; *v*, ventral or visceral arch, or wall of the body; *p*, *p*, pleuro-peritoneal cavity; *i*, alimentary canal; *h*, heart; *l*, *l*, the rudimentary limbs.

Fig. 4.—First dorsal vertebra with the first rib and upper part of the sternum, seen from above. ½

*C*, centrum; *N*, neural cavity; *V*, cavity of the chest, visceral cavity.

It is true that a segmented plan of construction is not restricted to vertebrate animals, but exists in several other classes of the animal kingdom, as is most conspicuously seen in the Arthropoda, such as insects and crustacea. In these animals, however, although there is a marked repetition of parts of like structure in a longitudinal series, there are many important deviations from the vertebrate type of organisation; and it is unnecessary here to trace the corre- dence between their structure and that of man.

In the human body, as in that of all vertebrate animals, the character of segmentation is most obvious in the osseous and nervous systems, so that the form and structure of the other systems seem to be in some measure moulded upon those of the skeleton and cerebro-spinal axis.

The trunk of the body more especially is formed of a series of parts or segments of similar structure sufficiently distinct in some of the systems, but more or less blended together in others. Such ideal segments of the body may be named *vertebral segments*, or *somatomes* (Goodsir). In the limbs, although in the earliest stages of their formation some segmental connection may be traced between them and the trunk, the repetition of vertebral elements is, in their more advanced state of growth, greatly obscured by the modifications of form and structure they have undergone.

**Homology.**—A certain agreement in structure, situation and connection of parts or organs constitutes what is called *homology*, and this term is generally employed to indicate the morphological identity of representative parts in different animals, which may be considered to have its cause in community of origin (*homogeny*, Lankester), while the anatomical correspondence of parts which are repeated in the same animal may be more exactly distinguished as *serial homology* (*homodynamy*, Gegenbaur). Thus the arm-bone or humerus of a man is homologous (homogenetic) with the upper bone of the fore limb of a quadruped, or of the wing of a bird, while it is at the same time serially homologous (homodynamic) with the thigh-bone of man himself, or any other vertebrate animal. It has farther been found convenient to express by the word *analogy* that kind of resemblance among the organs of animals which depends upon similarity of function, and although it may be accompanied by considerable agreement in structure, yet is not rendered complete by anatomical relation and connection: for example, the gills of a fish, of a crab, and of a mussel, serving the same function, are analogous organs, but in no sense homologous, as all morphological correspondence, or genetic relation is wanting between them. Thus also, the upper limb of a man, the fore limb of a quadruped, the wing of a bird, and the pectoral fin of a fish are homologous but not analogous structures, the wing of a bat and the wing of a bird are both homologous and analogous, whilst the last is analogous to but not homologous with the wing of an insect.

**Symmetry of Form.**—A remarkable regularity of form pervades the organisation of certain parts of the body, especially the whole of the limbs, the head and neck, and the framework, at least, and external walls of the trunk of the body. Thus, if we conceive the body to be divided equally by a plane which passes from its dorsal to its ventral aspect (*mesial plane*), the two halves, in so far as regards the parts previously mentioned, correspond almost exactly with each other, excepting by their lateral transposition,—and the human body thus presents in a marked manner the character of *lateral symmetry*. There is, however, a departure from this symmetrical form in the developed condition of certain of the internal organs, such as the alimentary canal from the stomach downwards, the heart and first part of the great bloodvessels, the liver, spleen, and some other viscera, which are therefore styled the asymmetrical parts or viscera.

**Descriptive Terms.**—In the description of parts so numerous, so various in form, and so complex in their connections as those composing the human body, there is difficulty in finding terms which shall indicate with sufficient precision their actual position and their relation to the rest of the organism. This difficulty is farther increased by the exceptional erect attitude in which the trunk of the human body is placed as compared with the horizontal position in animals. Hence, a number of terms have long been in use in human anatomy which are understood in a technical or restricted sense. For example, the *mesial plane*, already referred to, being that by which the body might be divided into right and left lateral halves, and the *middle* or *median line* being that in which the mesial plane meets the surface of the body, the words *internal* and *external* are used to denote relative nearness to and distance from this plane on either side, and might therefore be replaced by *mesial* and *lateral*. The terms *sagittal* and *frontal* are sometimes used in indication of direction within the body: sagittal denoting a dorso-ventral direction in or parallel to the mesial plane, frontal a transverse direction perpendicular to that plane. The words *anterior* and *posterior*, *superior* and *inferior*, and several others indicating position, are employed in human anatomy strictly with reference to the erect posture of the body. But now that the more extended study of comparative anatomy and embryonic development is largely applied to the elucidation of the human structure, it is very desirable that descriptive terms should be sought which may without ambiguity indicate position and relation in the organism at once in man and animals. Such terms as *dorsal* and *ventral*, *neural* and *visceral*, *cephalic* and *caudal*, *central* and *peripheral*, *proximal* and *distal*, *axial* and *appendicular*, *preaxial* and *postaxial*, are of this kind, and ought, whenever this may be done consistently with sufficient clearness of description, to take the place of those which are only applicable to the peculiar attitude of the human body, so as to bring the language of human and comparative anatomy as much as possible into conformity. In many instances, also, precision may be obtained by reference to certain fixed relations of parts, such as the *vertebral* and *sternal* aspects, the *radial* and *ulnar*, and the *tibial* and *fibular* borders, the *flexor* and *extensor* surfaces of the limbs, and similarly in other parts of the body.

**Arrangement.**—The following subdivision of the subject and order of treatment will be adopted in this work, viz.:—

In the First Volume.

1. Osteology, the Bones.
2. Arthrology, the Articulations.
3. Myology, the Voluntary Muscles, with which will be combined the Fasciæ and Aponeuroses.
4. Angeiology, the Distribution of the Blood-vessels and Lymphatics.
5. Neurology, the Distribution of the Nerves.
6. Superficial Anatomy and Topographical Anatomy of some regions.

In the Second Volume.

7. Histology or General Anatomy.
8. Splanchnology, the Viscera, including—
    - *a.* The Brain and Spinal Cord.
    - *b.* The Organs of the Senses.
    - *c.* The Heart.
    - *d.* The Lungs and Organs of Respiration.
    - *e.* The Organs of Digestion with the Accessory Glands.
    - *f.* The Urinary Organs.
    - *g.* The Organs of Reproduction.
9. Embryology or Development.

# OSTEOLOGY.

## THE SKELETON.

THE **Skeleton** or solid framework of the body is mainly formed of the bones, but is completed in some parts by the addition of cartilages. The bones are bound together by means of ligaments, and are so disposed as to support the softer parts, protect delicate organs, and give attachment to the muscles by which the different movements are executed.

In the lower animals the term skeleton has a wider signification than in man, comprehending two sets of parts, viz., 1st, those of the *endoskeleton*, or the deeper osseous and cartilaginous framework which corresponds to the human skeleton; and 2nd, those of the *exoskeleton*, or *dermal skeleton*, comprising the integument and various hardened structures connected with it. All vertebrate animals possess an endoskeleton; but in some of them the exoskeleton attains greater proportions than in others, and is combined by means of hardened parts more fully with portions of the endoskeleton. In most invertebrate animals the dermal or exoskeleton alone exists.

In man, as in the higher vertebrates, the greater part of the endoskeleton is formed of bone, a calcified animal tissue, which, when freed by putrefactive maceration from its fat and various soft adherent parts, and subsequently dried, is capable of remaining unchanged for a very long period of time. It is customary and convenient thus to study the bones chiefly in the macerated and dried state, that is, deprived of their accessory soft parts.

The accessory soft parts connected with the fresh bones consist chiefly of the external fibrous and vascular covering termed *periosteum*, and of the *medulla*, marrow or fat, which fills their larger internal cavities. The bones are permeated by blood-vessels, and they are provided also with absorbent vessels and with nerves in small quantity.

The ends of the bones, when jointed moveably with others, are covered by a thin layer of dense permanent cartilage, called articular cartilage; and the adjacent bones are united together by fibrous ligaments which may be considered as continuous with the periosteum covering the rest of the bones. In some instances distinct bones are directly united by means of ligament or cartilage without any joint-cavity intervening. Thus the osseous system as a whole may be considered to be enveloped by a fibrous covering.

The bones are originally formed by a process termed **ossification** from soft substance. This process commences in the greater number of bones in cartilage; in some it begins in fibrous tissue or membrane; and in all instances the further growth of the bone substance takes place largely in the latter way. The deposit of bone begins generally at one spot, which is therefore called the primary *centre* of ossification; but there may be several of these from the first. The main part of the bone thus formed from the primary centre is sometimes named the *diaphysis*. In most bones, after considerable advance in growth by extension from the primary centre, ossification occurs at comparatively later periods in one or more separate points, forming secondary or tertiary centres; and the portions of bones so formed, which remain united to the main part for a time by intervening cartilage, are termed *epiphyses*. In many instances entire consolidation of the bone by the osseous union of the epiphyses does not take place till the full size has been attained, and this may be as late as the twenty-third or even the twenty-fifth year of life.

In their **outward form** the bones present much diversity, but have been reduced by anatomists to the following classes:—1. Long or cylindrical, such as the chief bones of the limbs. These consist of a body or shaft, cylindrical or prismatic in shape, and two extremities which are usually thicker than the shaft, and have smooth cartilaginous surfaces for articulation with neighbouring bones. The shaft is generally hollow and filled with marrow, by which sufficient size and strength are attained without undue increase of weight. 2. Tabular or flat bones, like the scapula, ilium, and the bones forming the roof and sides of the skull. 3. Short bones, which are more or less cubical or oblong, as in the carpus and tarsus. 4. Irregular or mixed bones, mostly situated symmetrically across the mesial plane of the body, and often of a complex figure, such as the vertebræ.

In these differently shaped bones the osseous substance occurs in two forms, viz., the compact and the spongy. There is, however, no essential difference in structure or properties between these beyond that of thickness or thinness of the component material.

The surfaces of bones present various eminences, depressions, and other marks, to designate which the following terms are in common use. Any marked bony prominence is called a *process* or *apophysis*; a slender, sharp, or pointed eminence is named a *spine*, or *spinous process*; a blunt one a *tubercle*; a broad and rough one a *tuberosity*. The terms *crest*, *line*, and *ridge* are usually applied to a prominent border, or to an elevation running some way along the surface of a bone. A *head* (caput, capitulum, or capitellum) is a rounded process usually supported on a narrower part named the *neck* (cervix). The term *condyle*, somewhat variously applied by anatomists, is most frequently employed to denote an eminence bearing a rounded articular surface.

The cavities and depressions of bones are very variously named. An aperture or perforation, when short, is a *foramen*; when continued some way as a passage it is a *canal* or *meatus*. A narrow slit is a *fissure*, an open excavation or hollow in one bone or in several together is a *fossa*. This term is also sometimes applied to the socket of a joint, as in the *glenoid* or shallower, and the *cotyloid* or deeper form of joint cavity. *Sinus* and *antrum* are names applied to considerable cavities in the interior of certain bones. Besides these, various other terms are employed which do not require explanation, such as *notch* (incisura), *groove*, *furrow* (sulcus), &c.

**The number of bones** in the skeleton varies at different periods of life, some which are originally distinct becoming united together as the process of ossification advances. The following is a statement of the number usually reckoned as distinct in middle life :—

| | Single bones. | Pairs. | Total. |
|---|---|---|---|
| The vertebral column . . | 26 | .. | 26 |
| The skull . . . . . | 6 | 8 | 22 |
| The hyoid bone . . . | 1 | .. | 1 |
| The ribs and sternum . . | 1 | 12 | 25 |
| The upper limbs . . . | .. | 32 | 64 |
| The lower limbs . . . | .. | 31 | 62 |
| | 34 | 83 | 200 |

Besides the bones included in the above enumeration, there exist likewise the three pairs of auditory ossicles, and various bones formed in tendons and called *sesamoid*, the most constant of which are, besides the patella and pisiform bone, reckoned in the table above as limb bones, a pair in each thumb and great toe.

## I.—THE VERTEBRAL COLUMN.

The vertebral column is composed of a series of bones called *vertebræ*, which are united together, for the most part, by joints and elastic substance in such a manner that, although the amount of motion allowed between each pair is slight, the aggregate is sufficient to give the column very considerable flexibility. The vertebræ are originally thirty-three in number. Of these, the twenty-four upper remain separate in the adult, retaining their mobility, and are hence called *moveable* vertebræ. They are succeeded by five others, which rapidly diminish in size from above downwards, and which are united into one mass called the *sacrum;* beyond the sacrum are four dwindled terminal members of the series, which as age advances, likewise become more or less united, and form the *coccyx*. These sacral and coccygeal vertebræ are known as the *fixed* or *united* vertebræ.

**General characters of the Vertebræ.**—The general characters are best seen in the vertebræ placed near the middle of the column, of which the sixth dorsal vertebra, shown in Fig. 8, may serve as an example. Each has more or less the form of a ring, and presents for consideration a body, arch, processes, and the enclosed spinal foramen.

The *body* or *centrum* is a short cylinder or disc, which forms the anterior part of the vertebra. Its superior and inferior surfaces are flattened and connected to the next vertebræ by strong and elastic intervertebral discs. On the front and sides it is convex horizontally, but slightly concave from above downwards; its posterior surface forms part of the ring, and is slightly concave from side to side. These vertical surfaces are pierced by numerous small foramina for the passage of blood-vessels, and near the middle of the posterior surface are one or two much larger than the others.

The *arch* (*neural*) consists of two symmetrical portions which spring, one on each side, from the posterior surface of the body, and meet in the middle line behind. The anterior part of each half, thick and narrow, is called the *pedicle;* the posterior part is broad and flat, and is called the *lamina*. The concavities on the upper and lower borders of the pedicles are named *notches*, and constitute by the apposition of those of contiguous vertebræ, the *intervertebral foramina*, a series of rounded apertures, which communicate with the vertebral canal, and transmit the spinal nerves and blood vessels.

The *spinous process* (neural spine) projects backwards from the arch in the middle line. The *transverse processes*, placed one on each side, project outwards from the arch at the junction of the pedicle with the lamina. The *articular processes* (zygapophyses), two superior and two inferior, project upwards and downwards opposite the attachment of the transverse processes; their articular surfaces, coated with cartilage, in the superior pair look backwards, and in the inferior forwards, so that the former face the latter in adjoining vertebræ.

The *foramen* is bounded anteriorly by the body, posteriorly and laterally by the arch. The series of *rings* thus formed, united by ligaments, constitutes the *spinal* or *neural canal*, which lodges the spinal cord.

*Texture.*—The bodies of the vertebræ are almost entirely composed of spongy substance, the principal lamellæ being vertical; on the surface is a thin layer of compact tissue. Venous canals, commencing at the larger foramina behind, traverse the cancellated structure. The arch and processes contain a much smaller proportion of spongy substance, being covered with compact tissue of considerable density in some places.

### GROUPS OF VERTEBRÆ.

The vertebræ are divided into five groups, named from the regions which they occupy, *cervical, dorsal, lumbar, sacral,* and *coccygeal.*

**Cervical Vertebræ.**—These are seven in number; they are the smallest of the moveable vertebræ, and are specially characterized by the presence of foramina in the transverse processes. The first and second are so peculiar in form, as to require a separate description. The following are the common characters of a cervical vertebra.

Fig. 5.

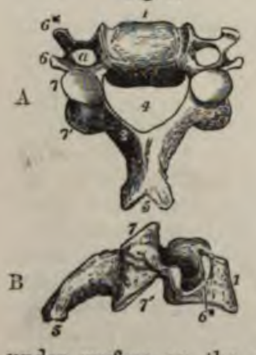


Fig. 5.—THIRD CERVICAL VERTEBRA. (A. T.) $\frac{1}{2}$

A, from above and slightly from behind; B, from the side. 1, body; 3, lamina; 4, spinal foramen; 5, spinous process; 6, posterior, 6*, anterior tubercle of transverse process; *a*, foramen in the transverse process transmitting the vertebral artery; behind *a*, the pedicle and intervertebral notch; 7, superior, 7′, inferior articular process.

The *body* is small and much broader from side to side than from before backwards; in depth nearly the same in front and behind. Its upper surface is transversely concave from the upward projection of its lateral margins, and is sloped down anteriorly. The under surface on the contrary is rounded off at the sides, while its anterior margin forms a marked projection downwards.

The *pedicles* spring from the body midway between the upper and lower borders, and are directed outwards and backwards: the *laminæ* are long and flat. The superior and inferior notches are nearly equal in depth.

The *spinous process* is short, only slightly depressed, and bifid.

The *transverse processes* are short and present at their extremities two tubercles, anterior and posterior. Each process is deeply grooved superiorly for a spinal nerve, and at its base is perforated vertically by a round foramen (vertebrarterial), through which in the upper six the vertebral artery and vein pass. It is united with the rest of the vertebra by two parts; by the posterior, at the place of junction of the pedicle and lamina, like a dorsal transverse process; by the anterior, to the body of the vertebra, in the same position as the heads of the ribs.

The *articular processes* are placed at the extremities of a short, stout, vertical column of bone; their flat articular surfaces are oblique, the superior looking backwards and upwards, the inferior forwards and downwards.

The *foramen* is triangular with rounded angles, and larger than in the dorsal or lumbar vertebræ.

**The First Cervical Vertebra**, or **Atlas**, differs remarkably from the others in the absence of a body and spinous process, having the form merely of a large ring with articular and transverse processes.

Fig. 6.

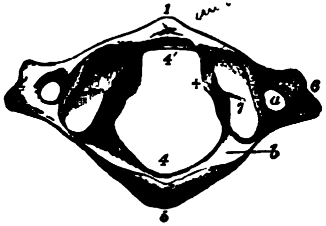


Fig. 6.—ATLAS, FROM ABOVE. (A. T.) ½

1, tubercle on anterior arch; 4, the posterior part of the ring, with 5, an indication of a spinous tubercle; 4′, the anterior part of the foramen, containing the odontoid process, and indicating in front of 4′ the smooth surface on which the process moves in rotation; 6, transverse process with a slight indication of division into two tubercles; 7, condylar articular process; + inside it indicates the rounded tubercle to which the transverse ligament is attached; *a*, foramen in the transverse process; *b*, groove on the posterior arch for the vertebral artery.

The interior of the ring is wider posteriorly than anteriorly. Its posterior part corresponds to the foramina of the other vertebræ; its narrower anterior part is occupied by the odontoid process of the axis, and in the recent state is separated from the posterior by the transverse ligament. In front of the ring is the *anterior arch*, on the anterior aspect of which is a small tubercle, and on the posterior a smooth surface for articulation with the odontoid process. At the sides of the ring are the *lateral masses*, which are thick and strong, bearing the articular processes superiorly and inferiorly, and extending outwards into the transverse processes. The articular processes differ from those of other vertebræ in being situated in front of the places of exit of the nerves. The superior are oval, converging in front, with articular surfaces concave from before backwards, and looking upwards and inwards; they are frequently divided by a transverse groove into two. At the inner margin of each is a smooth rounded tubercle, to which the transverse ligament is attached. The inferior articular processes are smaller than the superior, flat, nearly circular, looking downwards and slightly inwards.

The *posterior arch* presents in the middle line a rough elevation, the rudiment of a spinous process; at its junction with the lateral masses, it is hollowed out superiorly, so as to form a smooth transverse groove, in which lie the vertebral artery and first spinal (suboccipital) nerve; the groove is sometimes converted into a foramen by a small arch of bone, and corresponds to the notches of the other vertebræ.

The *transverse processes* are larger and project further outwards than those of the subjacent vertebræ. They are flattened from above downwards, and have a large foramen. Their extremities are not bifid, but broad and rough.

**The Second Vertebra** or **Axis** (vert. dentata) forms a pivot on which the first vertebra rotates carrying the head.

The *body* is characterized by the presence of a large blunt tooth-like process called *odontoid* (proc. dentatus). This consists of an enlarged part termed the *head*, and a lower part or *neck*. It presents in front a smooth surface for articulation with the atlas, and behind a smooth groove to receive the transverse ligament. The lower surface of the body resembles that of the succeeding vertebræ. Its anterior surface presents a low median vertical ridge, with a depression on each side.

Fig. 7.

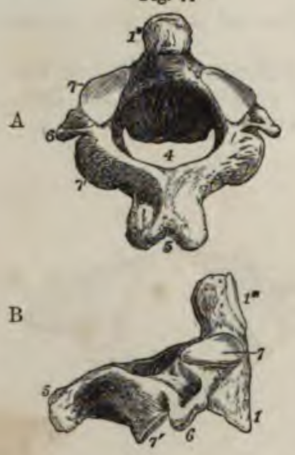


Fig. 7.—The axis. (A. T.) ½

A, seen from above and behind; B, seen from the right side. 1, body; 4, spinal foramen; 5, spinous process; 6, transverse process; 7, superior articular surface; 7′, inferior articular process; 1* in A, is placed at the side of the odontoid process; in B, in front of it, marking the smooth surface of articulation with the anterior arch of the atlas.

The superior *articular surfaces* placed like those of the atlas in front of the notch, lie close to the base of the odontoid process, partly on the body and partly on the pedicles of the vertebra. These surfaces look upwards and slightly outwards. The inferior articular processes are similar in form and position to those of the succeeding vertebræ.

The *spinous process* is very large, rough, deeply bifid, and grooved on its inferior surface. The *laminæ* are very thick and strong.

The *transverse processes* are short and the anterior tubercle almost obsolete. The foramen for the vertebral artery is inclined obliquely upwards and outwards.

**The Seventh Cervical Vertebra** (vert. prominens) has a long tuberculated spine, which projects under the skin (hence its name), and the transverse processes are massive, only slightly grooved, with a small foramen, and terminate in a single broad tubercle.

**Dorsal** or **Thoracic Vertebræ.**—These are twelve in number, and support the ribs.

The *body* as seen from above is somewhat heart-shaped; its antero-posterior and transverse diameters are nearly equal; its depth greater behind than before.

It is specially characterized by the presence, at the place where it joins the arch, of depressed articular surfaces for the heads of ribs. In the greater number of instances, there are two costal surfaces on each de,—one on the upper, the other on the lower border,—so placed that each completes, with that of the adjacent vertebra, a cavity for the head of one rib.

Fig. 8.

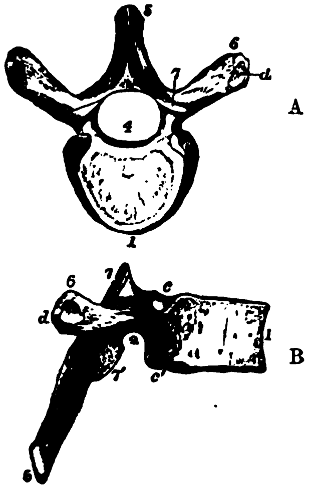


Fig. 8.—SIXTH DORSAL VERTEBRA. (A. T.) ½

A, viewed from above; B, viewed from the right side. 1, body; 2, pedicle; 3, lamina; 4, spinal foramen; 5, spinous process; 6, transverse process; 7, 7', superior and inferior articular processes; *c*, *c'*, superior and inferior facets on the body for the articulation of the head of the rib; *d*, facet on the transverse process for the articulation of the tubercle of the rib.

The *laminæ*, broad and flat, are imbricated or sloped one pair over another like tiles on a roof. The superior notches are very shallow, the inferior comparatively deep.

The *spinous process*, described as bayonet-shaped, is three-sided, and terminates in a slight tubercle. It is longest and has the greatest downward inclination in those toward the middle of the series.

The *transverse processes* are strong, directed outwards and backwards, and terminate in a rough knob which presents anteriorly a smooth surface for articulation with the tubercle of a rib.

The *articular processes* have their cartilaginous surfaces nearly vertical. Those of the superior processes look backwards, slightly upwards and outwards, those of the inferior look forwards, slightly downwards and inwards.

The *foramen* is nearly circular, and is smaller than in the cervical or the lumbar region.

The first, tenth, eleventh, and twelfth dorsal vertebræ present certain characters by which they may be individually distinguished.

The **First Dorsal Vertebra** in its general conformation approaches very closely the seventh cervical. The body is elongated transversely and concave on the upper surface; the superior intervertebral notches are of considerable depth; the upper articular surfaces oblique, and the spinous process long and nearly horizontal. On each side of the body is a complete circular facet close to the upper border for the first rib, and a demi-facet below for the second.

The **Tenth Dorsal Vertebra** touches only one rib on each side, and has a single nearly complete articular surface, mainly on the pedicle. There is the usual facet on the transverse process.

The **Eleventh Dorsal Vertebra** has a complete articular surface on each side for the head of the rib, but no facet on the transverse process.

The **Twelfth Dorsal Vertebra** has also only a single facet on each side; the inferior articular processes have their surfaces turned outwards, resembling those of a lumbar vertebra; the transverse processes are short and present three elevations, the *external*, *superior*, and *inferior* tubercles, which correspond to the transverse, mammillary, and accessory processes of the lumbar vertebræ (v. fig. 10, 6, *e*, *f*). Indications of these tubercles are also seen upon the tenth and eleventh vertebræ.

**Lumbar Vertebræ.**—These are five in number, the largest of the moveable vertebræ, and are distinguished by the absence of costal articular surfaces.

Fig. 9.

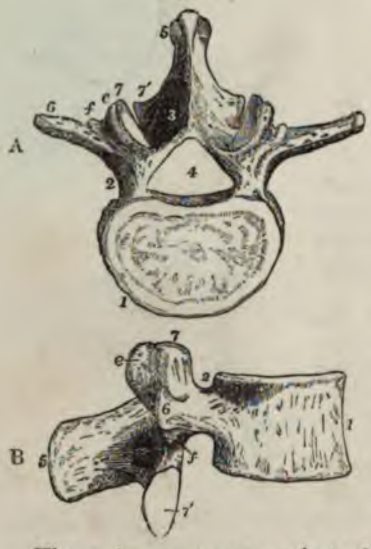


Fig. 9.—Third lumbar vertebra. (A.T.) ½

A, from above; B, from the right side; 1, body; 2, pedicle and intervertebral notch; 3, lamina; 4, spinal foramen; 5, spinous process; 6, transverse process; 7, 7′, superior and inferior articular processes; *e*, mammillary tubercle, apparently on the superior articular process; *f*, accessory tubercle, between the articular and transverse processes.

The *body* has a greater diameter transversely than from before backwards, and viewed from above or below its surface presents a reniform outline; the depth is about equal in front and behind.

The *laminæ* are shorter, deeper, and thicker than those of the dorsal vertebræ. The superior *notches* are shallow, the inferior deep.

The *spinous process* projects horizontally backwards. It has considerable breadth from above downwards, and is thickened and rough along its posterior edge.

Fig. 10.

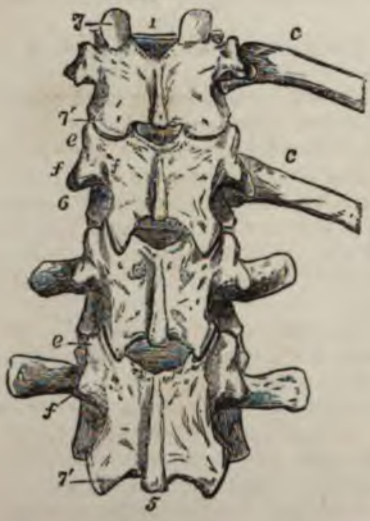


Fig. 10.—Lower two dorsal and upper two lumbar vertebræ. (A. T.) ½

Viewed from behind, chiefly to show the relations of the transverse processes and adjacent tubercles. 1, body of the eleventh dorsal vertebra; 5, spinous process of the second lumbar; 6, external or costal tubercle of the transverse process; 7, 7′, superior and inferior articular processes; *e*, superior or mammillary, and *f*, inferior or accessory tubercle; *c*, *c*, eleventh and twelfth ribs.

The *transverse processes*, slender and somewhat spatula-shaped, project directly outwards; they are shortest in the first, longest in the third vertebra. Their extremities lie in series with the external tubercles of the lower dorsal transverse processes, and with the ribs. Behind each at its base is a small process pointing downwards, which corresponds to the inferior tubercle of the dorsal transverse process, and is called the *accessory process* (anapophysis).

The *articular processes* are thick and strong. Their articular surfaces are vertical; the superior, concave, look backwards and inwards, the inferior, convex, look forwards and outwards. The superior pair are further apart than the inferior, and embrace the inferior pair of the vertebra above them. From each superior articular process a tubercle projects backwards, which corresponds to the superior tubercle of the dorsal transverse process, and is called the *mammillary process* (metapophysis).

The *foramen* is large and triangular, or widely lozenge-shaped.

The **Fifth Lumbar Vertebra** is massive, the body is deeper in front than behind, the transverse processes are broad and conical, the lower articular processes are wider apart than the upper, and the laminæ project into the spinal foramen on each side.

**Sacral Vertebræ.**—These by their union in the adult form the *os sacrum*, but in youth they present the elements of five distinct vertebræ. The sacrum is placed below the last lumbar vertebra, and articulates laterally with the two hip-bones, thus completing together with the coccyx the wall of the pelvis above and behind. The uppermost vertebra is the largest, those which follow become rapidly smaller and the fifth is rudimentary. Hence the sacrum has the form of a triangle with its base directed upwards. It is concave and smooth in front, convex and uneven behind. The direction of its surfaces is very oblique, its ventral aspect looking considerably downwards, and forming above at the place where it joins the last lumbar vertebra, the projection termed *promontory*. The dorsal or posterior surface looks upwards as well as backwards.

Fig. 11.

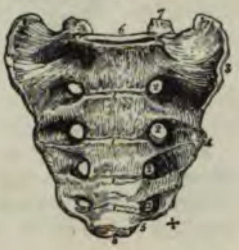


Fig. 11.—SACRUM OF THE MALE, VIEWED FROM BEFORE. ¼

1, 1, four transverse ridges, indicating the place of original separation of the bodies of the five sacral vertebræ; 2, anterior sacral foramina; 3, 4, lateral surface; 5, a notch which, with the coccyx, forms a passage for the fifth sacral nerve; 6, oval surface of the upper part of the sacrum for articulation with the body of the last lumbar vertebra; 7, superior articular process; 8, inferior oval surface for articulation with the coccyx; +, inferior lateral angle.

The ventral surface is concave from above downwards, and slightly so from side to side. It is traversed horizontally by four ridges, which indicate the places of union of the bodies of the five sacral vertebræ, and at the extremities of which are situated on each side four *foramina* called *anterior sacral*. These foramina lead externally into grooves, and diminish in size from above downwards.

The dorsal surface is convex, very uneven, and somewhat narrower than the ventral. It presents along the median line three or four small eminences, the spinous processes, usually more or less connected, so as to form a ridge. Below the last spinous process is a triangular opening, the termination of the spinal canal, the lateral margins of which are formed by the imperfect laminæ of the fourth and fifth sacral vertebræ, and are produced downwards into a pair of tubercles, the *sacral cornua*, which articulate with the cornua of the coccyx. On each side of the ridge of spines the surface formed by the united laminæ is slightly grooved longitudinally, and beyond this are the four *posterior sacral foramina*, opposite to, but smaller than the anterior. Immediately internal to each foramen is a slight eminence, which represents the articular and mammillary processes of the vertebræ above, whilst external to the foramen a more strongly marked elevation corresponds to the transverse process.

The part of the sacrum external to the foramina constitutes the *lateral mass*, and is broad and thick superiorly, but narrowed inferiorly. The outer aspect of the upper part presents in front a large uneven surface, covered in the recent state with cartilage, which articulates with the ilium, and is called from its shape the *auricular surface:* behind this the bone is rough and marked with strong depressions for the attachment of ligaments. Lower down, the margin becomes narrowed and sinuous, terminating in the projection called the *inferior lateral angle*, below which the breadth of the bone is suddenly contracted so as to form a notch with the adjacent part of the coccyx.

Fig. 12.

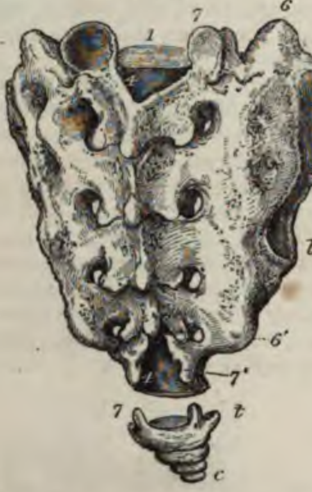


Fig. 12.—Sacrum and coccyx of the male viewed from behind. (A. T.) ½

1, Body of the first sacral vertebra; 4, 4, orifices of the sacral canal, and between these, the series of four united laminæ and spinous processes; 6, 6', line of tubercles corresponding to transverse processes; 7, 7', line of articular processes, with four adjacent posterior sacral foramina; *l*, *l*, auricular surface; in the coccyx, *c*, body of the last vertebra; *t*, transverse process; 7, cornu or superior articular process.

The *base* or upper surface of the first sacral vertebra bears considerable resemblance to the upper surface of the last lumbar. In the middle it presents the reniform surface of the body, behind which is the triangular aperture of the sacral canal, bounded by the depressed laminæ. On each side of the aperture is an articular process, exactly resembling the superior process of a lumbar vertebra. In front of this is a groove which forms with the last lumbar an intervertebral foramen. The external portion of the base presents posteriorly an eminence corresponding to the lumbar transverse process, and in front of that a large smooth curved

Fig. 13.

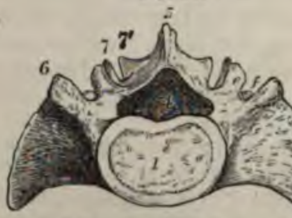


Fig. 13.—Upper surface or base of the sacrum of a male. (A. T.) ½

1, body; 4, foramen or sacral canal; 5, spinous process of the first sacral vertebra; 6, part corresponding to a transverse process, in front of which is the ala; 7, 7', superior and inferior articular processes; *e*, mammillary tubercle; *f*, accessory tubercle, slightly seen.

surface, continuous with the iliac fossa of the pelvis, and known as the *ala* of the sacrum.

The lower end or *apex*, formed by the small inferior surface of the body of the fifth sacral vertebra, is transversely oval, and articulates with the coccyx.

The *sacral canal* is curved with the bone, and gradually narrows as it descends; in transverse section it is three-sided above, but flattened and rather semilunar below. It terminates on the posterior surface of the bone between the sacral cornua where the laminæ of the last sacral vertebra are imperfect. From this canal there pass outwards in the substance of the bone four pairs of intervertebral foramina, closed externally by the lateral masses, but opening on the surface by the anterior and posterior sacral foramina.

*Differences in the sexes.*—The sacrum of the female is broader in proportion to its length than that of the male; it is also flatter, and usually inclines backwards from the direction of the lumbar vertebræ to a greater extent than in the male. But the curvature varies considerably in different skeletons.

*Varieties.*—The sacrum not unfrequently consists of six vertebræ, and sometimes, though rarely, of only four. Occasionally the bodies of the first and second vertebræ are not united, though complete union has taken place in every other part, or the first vertebra may present on one side the usual sacral form, while on the other it has the form of a lumbar vertebra, and is not united to the next (see fig. 21, 11, 1′), a peculiarity connected with the oblique form of pelvis. Instances also occur, in which it presents, on both sides, characters intermediate between those of sacral and lumbar vertebræ. The lower end of the sacral canal may be open to a greater extent than usual; it has even been found open throughout.

**Coccygeal Vertebræ, Coccyx.**—These are very rudimentary vertebræ, commonly four, sometimes five, seldom only three in number. The first of the series is considerably broader than the others. It presents superiorly on the part corresponding to the body an oval concave surface which articulates with the lower end of the sacrum; two small processes, termed *cornua*, which project upwards from its posterior surface, connected to the sacral cornua; and a short process, which projects from each side, and usually forms, with the inferior lateral angle of the sacrum, a notch for the fifth sacral nerve, but in some cases unites with that bone to enclose a fifth sacral foramen.

Fig. 14.

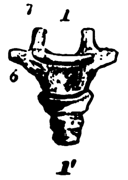


Fig. 14.—COCCYGEAL VERTEBRÆ, SEEN FROM BEFORE.—FROM A MALE SUBJECT OF MIDDLE AGE. (A. T.) ½

The upper piece is separate from the second; the three lower are united together in one piece, and separated only by grooves. 1, above the body of the first coccygeal vertebra; 1′, below the fourth piece; 6, the transverse process; 7, the cornua.

The remaining three coccygeal vertebræ are much smaller than the first, and correspond solely to vertebral bodies. When separate, the second piece presents an upper and lower flattened surface. The third and fourth pieces are mere rounded nodules. In middle life, the first piece is usually separate, while the three lower pieces are united into one, the original separation being indicated by transverse grooves.

In advanced life, the coccygeal vertebræ, having been previously joined into one bone, may become also united to the sacrum. This union occurs at an earlier age and more frequently in the male than in the female, but it is subject to much variation. The first piece often joins the sacrum before the union of the rest of the bone.

Fig. 15.

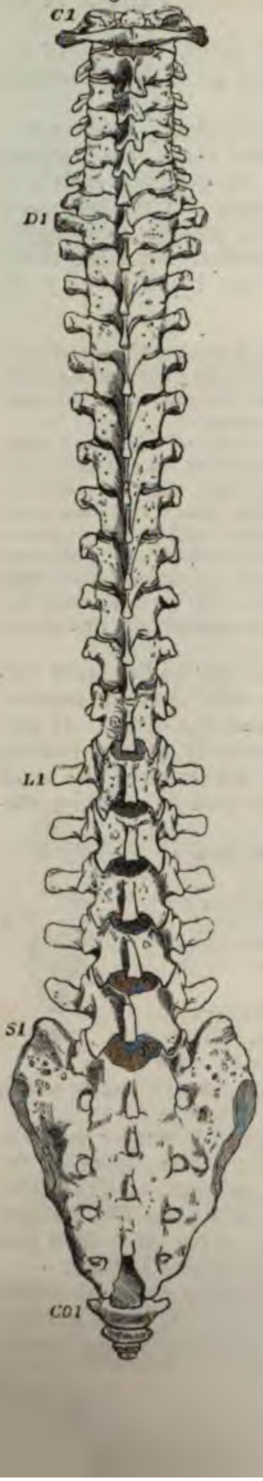


Fig. 15.—VERTEBRAL COLUMN OF AN ADULT MALE, SEEN FROM BEHIND. (A. T.) ¼

C 1, first cervical vertebra; D 1, first dorsal vertebra; L 1, first lumbar vertebra; S 1, first sacral vertebra; CO 1, first coccygeal vertebra. The transition in the form of the transverse processes and tubercles in the lower dorsal and first lumbar vertebræ is well marked in this specimen.

**The vertebral column as a whole.**—The vertebral column may be regarded as a central column upon which the other parts of the skeleton are arranged. Superiorly it supports the skull, laterally the ribs, through which also it receives the weight of the upper limbs, and near its lower extremity it rests upon the hip bones, by which it transmits the weight of the body to the lower limbs. It is a pillar of support to the rest of the skeleton, and protects the spinal cord by enclosing it in a bony canal. Its average length is about 28 inches.

When seen in profile the column presents four curves, directed alternately forwards and backwards,—forwards in the cervical and lumbar regions, backwards in the dorsal and sacral. The upper curves pass imperceptibly into one another, but at the junction of the last lumbar vertebra with the sacrum a considerable angle is formed, known as the *sacro-vertebral angle*, causing the promontory to overhang the cavity of the pelvis. The dorsal and sacral curves are primary curves, affecting those parts of the column which enter into the formation of the bony-walled cavities, the thorax and pelvis; they make their appearance at an early period of fœtal life, and are due to the conformation of the vertebral bodies: the cervical and lumbar curves are secondary or compensatory curves, necessary to the upright posture, only developed after birth, and dependent mainly on the shape of the intervertebral discs; in these regions also the principal movements of the spine take place. The curves obviously confer upon the column greater elasticity and security from injury than it would have were it perfectly straight. In the upper dorsal region there is also very frequently a slight degree of lateral curvature, the convexity of which, in most cases, is directed towards the right side, and is probably connected with the greater use made of the right than of the left arm.

Viewed in front, the bodies of the vertebræ are seen to become broader from the axis to the first dorsal, then slightly narrower to the fourth dorsal, and from that vertebra they gradually widen to the base of the sacrum. The width between the extremities of the transverse processes is considerable in the atlas; small in the axis, it becomes greater as far as the first dorsal vertebra, thence it is again gradually contracted as far as the last dorsal, and becomes suddenly much greater in the lumbar region.

In a lateral view the antero-posterior diameter of the bodies increases in descending through the dorsal and lumbar regions.

Viewed from behind the spines occupy the middle line. On the sides are the *vertebral grooves*, corresponding to the laminæ, and bounded externally in the cervical and dorsal regions by the transverse processes, and in the lumbar by the mammillary processes. Along each groove is a series of spaces between the laminæ, which, in the natural condition, are filled up by the yellow ligaments. The extent of these intervals is very trifling in the neck and in the greater part of the back; it increases in the lower third of the dorsal, and still more in the lumbar region. The interval between the occipital bone and the arch of the atlas is considerable, and so is that between the last lumbar vertebra and the sacrum.

The only part of the vertebral column that appears on the surface of the body is the row of spinous processes, and these

Fig. 16.

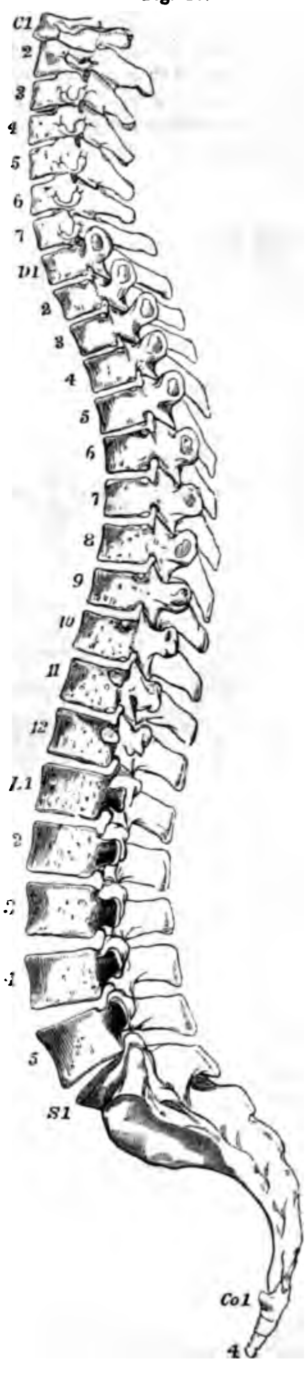


Fig. 16.—THE VERTEBRAL COLUMN VIEWED FROM THE LEFT SIDE. (A. T.) ¼

The letters and numbers indicate the several vertebræ. The antero-posterior curvatures of the column are shown, together with the shape and size of the bodies and intervertebral spaces, the form and transitions of the transverse and spinous processes, and the differences in the costal articulating surfaces.

are subcutaneous from the seventh cervical to the third sacral. The upper cervical spines are deeply placed and can be felt with difficulty in the median interval between the muscular masses of the back of the neck; the sixth is sometimes long and in such cases may project. The seventh cervical and the following one or two dorsal spines are prominent, the others lie at the bottom of the long *spinal furrow* produced by the eminence of the spinal muscles on each side.

### OSSIFICATION OF THE VERTEBRÆ.

**The Vertebræ in general.**—The ossification of each vertebra proceeds in cartilage from three principal centres, one for the main part of the body, and one on each side for the arch and processes, together with a part on each side of the body. The lateral centres appear about the 7th week of fœtal life, that of the body very soon afterwards. From these centres the ossification extends gradually, so as to form the greater part of the vertebra. That of the body does not pass, however, in the dorsal vertebræ the place of articulation of the head of the rib, leaving on each side a portion of the body which is formed from the lateral centre, and is separated up to the third year by a narrow cartilaginous interval—the *neuro-central suture*. It would appear further, that while ossification in the arches commences first in the cervical vertebræ, the osseous centres of the bodies appear earliest in the lower dorsal vertebræ.

Fig. 17.

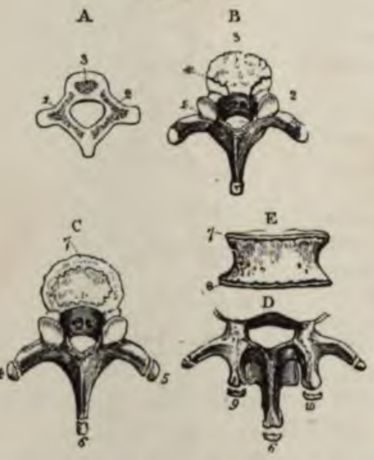


Fig. 17.—Ossification of the Vertebræ. (R. Quain.)

A, fœtal vertebra, showing the three primary centres; 1, 2, neural ossifications; 3, central ossification.

B, dorsal vertebra from a child of two years; 1 & 2 are seen to have encroached upon the body at * the neuro-central suture, to have extended into the articular and transverse processes, and to have united behind in the spinous process, leaving the ends cartilaginous.

C, dorsal vertebra at about seventeen years, showing epiphyses on the transverse processes, 4 & 5, and spinous process, 6, and the upper epiphysial plate of the body, 7.

D & E, parts of a lumbar vertebra of about the same age, showing, in addition to the foregoing, 8, the lower epiphysial plate of the body; 9 & 10, the epiphyses of the mammillary tubercles.

At the time of birth most of the vertebræ consist of three osseous pieces, corresponding to the three original centres. In the first year of infancy the laminæ of opposite sides become united in a number of the vertebræ, but not in all. The spinous processes, remaining cartilaginous for a time, are gradually completed by the growth of the cartilage and the extension of the bone into them, and at the same time, by the ossific extension of the transverse processes and other parts, the vertebræ gradually attain to nearly their full size and shape about the age of puberty. At different periods subsequent to this, five epiphyses, or supplementary centres of ossification, are added. Three of these are small portions of bone, placed on the tips of the spinous and transverse processes: the other two are thin annular plates on the upper and lower surfaces of the body at its circumference. In the lumbar vertebræ two other epiphyses surmount the mammillary processes. These epiphyses appear from the sixteenth to the twentieth year, and are not wholly united to the rest of the vertebra before the twenty-fifth year. The transverse process of the first lumbar vertebra is sometimes developed altogether from a separate centre. Most of the anterior divisions of the cervical transverse processes are ossified by the extension into them of osseous substance from the neighbouring posterior part of the process and from the arch; but those of the seventh usually present a separate osseous nucleus, and small nuclei have also been observed by Meckel in those of the second, fifth, and sixth vertebræ.

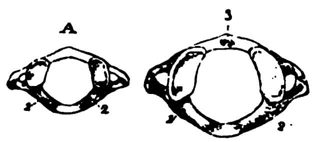
**The Atlas and Axis.**—The ossification of the atlas and axis differs considerably from that of the other vertebræ. In the atlas, the body being absent, the anterior arch is formed by a strip of cartilage in which ossification, commencing by one or two centres, only appears in the course of the first year after birth. The neural arch, together with the processes, is formed from two lateral centres corresponding with those of the other vertebræ, and which begin to ossify about the 7th week. Their union posteriorly occurs in the 3rd year, and is frequently preceded by the formation of a distinct spinal nucleus. Their union with the nucleus of the anterior arch does not take place till the 5th or 6th year.

Fig. 18.—Ossification of the atlas. (R. Quain.)

A, before birth; 1 & 2, lateral centres of ossification; the anterior arch is cartilaginous.

B, in the first year; 1 & 2, as before; 3, ossific centre in the anterior arch.

Fig. 18.



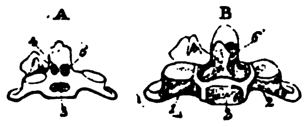
In the axis the arch and processes are formed from two centres corresponding to those of the other vertebræ, and appearing about the 7th or 8th week. Ossification begins in the body about the 4th month, from one or sometimes two centres, occupying the lower part of the common cartilage of the body and odontoid process. In the upper part of this cartilage, a little later, two collateral centres appear for the odontoid process; these soon unite into one, and become ossified to the body of the axis in the 3rd year. There is also a distinct centre in the apex of the process appearing in the 2nd year. The separate ossification of the odontoid process is important in connection with the view that it is the displaced body of the atlas.

Fig. 19.—Ossification of the axis as seen in front. (R. Quain.)

A, from a fœtus of seven months; 3, the centre for the body; 4 & 5, two centres for the base of the odontoid process.

B, shortly after birth; 1 & 2 the lateral centres; 3, centre for the body; 6, the two centres for the odontoid process now united.

Fig. 19.



**Sacral Vertebræ.**—Each of the sacral vertebræ presents three primary centres of ossification, one in the body and a pair in the arch. The centres of the bodies of the first three vertebræ appear about the 8th or 9th week, those of the two following vertebræ somewhat later. The laminæ begin to ossify about the 6th month, but the time of union with the bodies differs in the different vertebræ; taking place as early as the 2nd year in the lowest, but not till the 5th or 6th year in the uppermost. In each of the first three vertebræ (sometimes however only in two, sometimes in four) the anterior part of the lateral mass on each side is formed from an additional nucleus which appears at the outer margin of the anterior sacral foramen from the 6th to the 8th month. These unite to the bodies later than the arches. In the case of the two lower vertebræ, the lateral masses are formed by extension of ossification from the primary lateral nuclei. On the body of each vertebra, epiphysial plates are formed after puberty, as in other vertebræ, and two flat irregular plates of bone are added to each lateral surface of the sacrum, the uppermost of which extends over the auricular surface and the lower over the sharp edge below. These appear from the 18th to the 20th year, and are united about the 25th. The bodies of the sacral vertebræ are at first separated by intervertebral discs, but about the 18th year, in the case of the lower vertebræ, ossification begins to extend through these discs and the epiphyses, so as completely to unite the adjacent bodies. The ossific union of the first and second bodies does not take place till the 25th year or later. Previous to this, the lateral masses have coalesced nearly in the same order as the bodies.

The deficiency of the spine and dorsal part of the laminæ usually existing in the fifth sacral vertebra, and not unfrequently extending to the fourth, but more rarely to the third, may be attributed in part to the non-extension of ossification in that direction: but such varieties of form, like many others to which the sacral vertebræ are subject, are probably intimately connected with the nature and development of the formative matrix of the bones. The more completely open state of the sacral canal posteriorly found in cases of spina bifida is undoubtedly connected with early morbid changes interfering with the natural process of development.

Fig. 20.

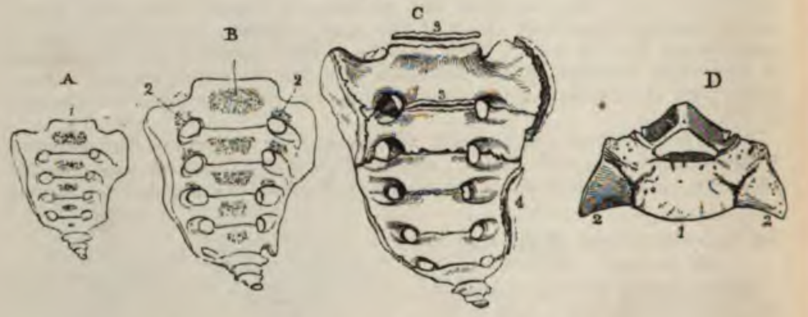


Fig. 20.—Ossification of the sacrum. (R. Quain.)

A, sacrum of a fœtus before six months, seen from the front, showing the ossific centre in the body of each vertebra, from 1 downwards.

B, at birth; 2, 2, additional centres for the lateral masses.

C, about twenty-three years; 3, 3, epiphysial plates still visible above and below the first vertebral body, the fissures still remaining between the first and second and the second and third lateral masses; 4, 4′, lateral epiphysial plates.

D, upper surface of first sacral vertebra at four or five years, 1, and 2, as in A and B. (A. T.)

A & B, nearly full size; C, one-fourth; D, one-third.

**Coccygeal Vertebræ.**—Each of the coccygeal vertebræ is ossified from a distinct piece of cartilage, and usually from a single centre, but in the upper sometimes from two centres. Ossification commences in the first generally about the time of birth; in the second, from the 5th to the 10th year; in the third, some time before, and in the fourth, some time after puberty. The ossific union of the three lower coccygeal vertebræ occurs before middle life; their union with the first, and the union of this with the sacrum, belong to the later periods of life.

For more detailed information concerning the ossification of the vertebræ, as well as of the bones generally, reference may be made to Rambaud et Renault, "Origine et Développement des Os," Paris, 1864.

### GENERAL AND SERIAL HOMOLOGY OF THE VERTEBRÆ.

The study of the various forms presented by the parts of the vertebral column, and of its relation to the rest of the skeleton in man and animals, as also of its development in the fœtus, has led to the formation of the general views of homology referred to in the introduction. These views originated, in somewhat different forms, mainly with Oken, Carus, Geoffroy St. Hilaire, and Owen; and, with various modifications and extensions by more recent writers, as Goodsir, Huxley, Gegenbaur, St. George Mivart, and Flower, are now admitted by almost all anatomists, in some shape or other, as the basis of a morphological doctrine of the construction of the skeleton. There is not, indeed, an entire agreement among anatomists with respect to some parts of this doctrine; but still there is such a general acknowledgment of both the zoological and serial homology of the parts composing the skeleton, that considerations of this kind cannot be entirely omitted in a work on human anatomy. At the same time, it is obvious that the complicated nature of the subject, and the necessity for frequent reference to details of comparative anatomy for its elucidation make it impossible to enter fully into its consideration here, so that our remarks must be limited to those points in which the views of homology have the most immediate bearing upon the knowledge of human anatomy. The accompanying views of the several vertebræ and some of their varieties as seen from above (in fig. 21) may assist the reader in comparing their forms.

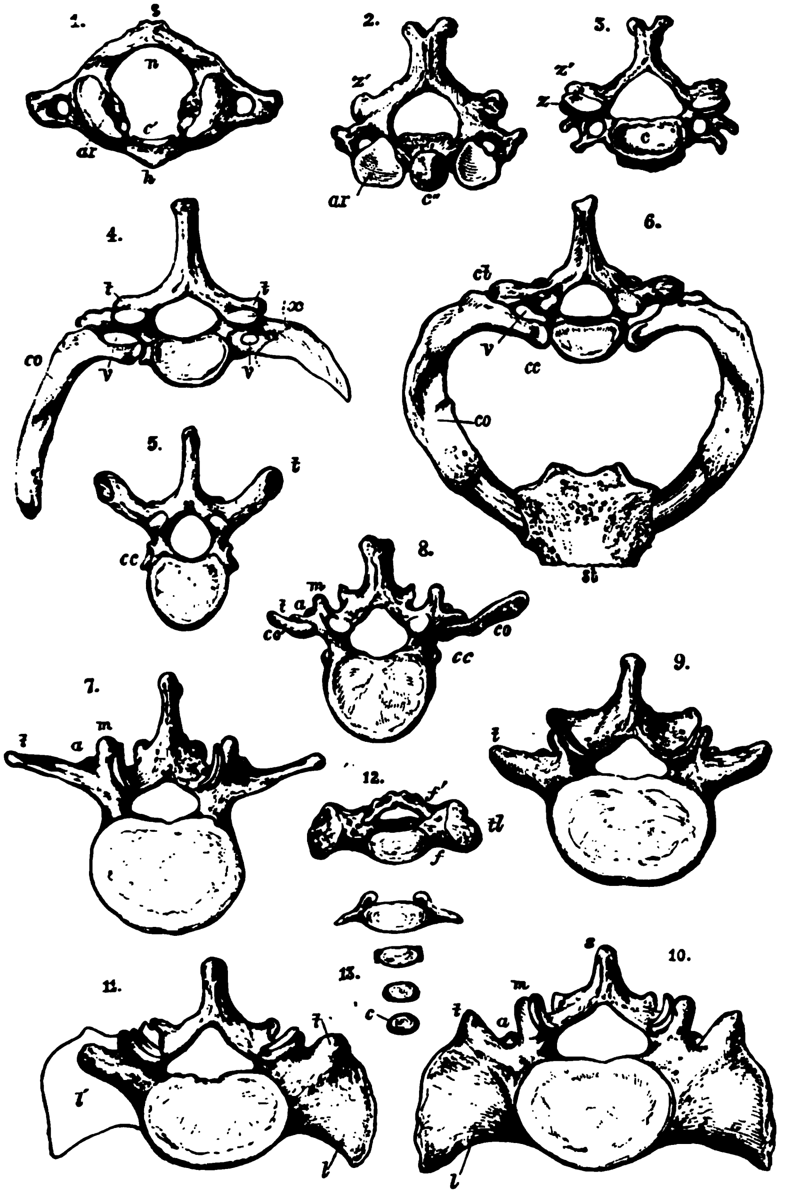
1. The **series of centra** or **bodies**, surrounding the primary axis of the notochord, is complete in man, from the odontoid process of the second vertebra to the caudal extremity. In the head it is ascertained to be prolonged into the basioccipital and basisphenoid parts of the base of the skull. It is apparently absent in the atlas, or rather the part corresponding to the centrum or body of that vertebra is united with the body of the axis in the odontoid process: while the anterior arch of the atlas belongs to a different series of parts, not yet accurately determined, perhaps to the precentral or subcentral parts or *hypapophyses*. The proofs of this view are derived mainly from, 1st, the remains of the notochord having been actually traced in the fœtus through the odontoid process (and not through the anterior arch of the atlas) into the basioccipital bone; 2nd, the separate ossification in cartilage of the odontoid process; and 3rd, the existence in some animals, as the ornithorynchus and some reptiles, of a bone corresponding to the odontoid process, in a separate condition, without any other part representing the body of the atlas.

2. The **series of neural arches** is complete in the whole vertebral column of man, with the exception of the three lowest coccygeal vertebræ, and in part of the upper coccygeal and lowest sacral vertebræ. The neural spines are also complete in nearly the same vertebræ as the arches. The spine is absent or little developed in the atlas, bifid at its extremity in the next five cervical vertebræ, but simple in all the remaining vertebræ in which it is present.

3. The **articular processes**, or **zygapophyses**, superior and inferior (preaxial and postaxial), correspond in their relations throughout the whole of the vertebræ in which they exist, with the exception of both of those of the atlas and the superior of the axis. In these last mentioned vertebræ the articular processes are not in the series of zygapophyses, being situated at the place of union of the pedicles with the bodies, or nearly in the place of the capitular articulation of the ribs with the vertebral bodies, and therefore anterior to the place of exit of the spinal nerves, instead of posterior to it as in the other vertebræ. In the sacral vertebræ the articular processes, existing as such in early life, come to be in the adult united by anchylosis. In the three lower coccygeal vertebræ they are absent.

4. It is in the comparison of the parts known in human anatomy under the general name of **transverse processes** that the main difficulty of establishing homologies exists. In all the cervical vertebræ the processes so called are pierced by a vertebrarterial foramen, and the most of them have two tubercles. Those of the dorsal vertebræ are for the most part simple, but are articulated at two places with the ribs. At these two places are situated processes, sometimes projecting in animals to a considerable extent; of which the dorsal, forming the costo-transverse articulation, is known as the *tubercular process* (diapophysis); and the ventral, forming the costo-central articulation, is named the *capitular process* (parapophysis) and is placed close to the body, but separated from it by the neuro-central suture. It is very generally admitted that the part in front of the vertebrarterial foramen of

Fig. 21.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## II.—THE THORAX.

The skeleton of the thorax consists of the dorsal vertebræ already described, the sternum, the ribs, and the costal cartilages.

### THE STERNUM OR BREAST-BONE.

The **sternum** is situated in the median line at the fore part of the thorax. It is connected with the rest of the trunk by the cartilages of the first seven pairs of ribs, and gives attachment to the clavicles. It consists originally of six segments. The first of these usually remains distinct up to advanced life, and is called the *manubrium* or *presternum:* the succeeding four are united into one in the adult, and form the *body* or *mesosternum:* the sixth generally remains cartilaginous for some years after birth, and sometimes partially so even to advanced age, constituting the *ensiform process*, or *metasternum;* in middle life it is most frequently ossified and united by bone to the body.

The sternum is flattened from before backwards, and presents a slight vertical curve with the convexity in front. It is of unequal width, being broad at the upper part of the presternum, considerably narrower at the lower end of that portion and in the first segment of the mesosternum, somewhat wider near the lower end of that portion, and finally narrowed near the junction with the metasternum. It consists of light cancellated tissue, with a thin covering of compact bone.

The **presternum** is the thickest part of the bone. Its anterior surface presents a slight median elevation, its posterior is smooth and somewhat concave. Its upper border is divided into three deep notches; the middle one is named the *incisura semilunaris*, or *interclavicular notch;* the lateral ones form two depressed articular surfaces directed upwards, outwards and backwards, for articulation with the clavicles, *clavicular notches.* Each lateral border presents superiorly close to the clavicular notch, a rough triangular surface, which unites with the cartilage of the first rib. Below this the bone slopes inwards, and at its inferior angle presents a small surface, which with a similar one on the mesosternum forms a notch for the cartilage of the second rib. The lower margin is straight and united by cartilage to the upper margin of the mesosternum.

Fig. 22.

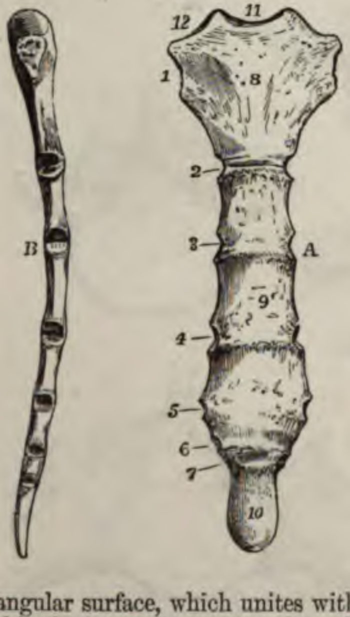

Fig. 22.—THE STERNUM OF A MIDDLE-AGED MAN. (A. T.) ⅓

A, from before; 1, 2, 3, 4, 5, 6, & 7, the articular surfaces for the corresponding costal cartilages; 8, manubrium still separate from the body; 9, body; 10, ensiform process, osseous, and united to the body; 11, interclavicular notch; 12, clavicular notch.

B, the same sternum viewed from the right side, showing the general convexity of the bone forwards. The different facets of articulation with the clavicle and costal cartilages will be distinguished by their position in comparing the figure B. with A.

The **mesosternum** is marked on its anterior surface by three slight transverse elevations at the lines of junction of its four component parts. Its posterior surface is comparatively smooth. Each lateral margin presents five notches for the reception of costal cartilages, and a small surface superiorly, which, with the similar depression on the presternum, forms the notch for the second costal cartilage. The notches for the third, fourth, and fifth costal cartilages are opposite the lines of junction of the four segments of the body of the sternum; those of the sixth and seventh are placed close together on the sides of the inferior segment, that for the seventh being completed by the ensiform process.

The **metasternum**, ensiform process, or xiphisternum, is a thin spatula-like process projecting downwards between the cartilages of the seventh ribs. It is subject to frequent varieties of form; being sometimes bent forwards, sometimes backwards, often forked, and sometimes perforated.

The sternum is subcutaneous in the middle line, forming the floor of the *sternal groove* between the pectoral muscles which cover the lateral portions of the anterior surface. The upper end is marked by the deep *suprasternal notch*, and the ensiform process lies at the bottom of the *infrasternal depression*, the latter being due to the prominence of the mesosternum and the seventh costal cartilages beyond the surface of the xiphisternum.

The sternum is subject to many varieties of form. It is not unfrequently much shorter than usual, and indented at its lower part, as occurs especially from the pressure of the cobbler's last. Occasionally the lower part of the body is perforated by the so-called *foramen sternale* (fig. 26, E.); and in rare cases the sternum has been found divided to a greater or less extent, constituting the malformation of fissura sterni, and connected in some instances with ectopia cordis. (Case of E. Groux, described by Allen Thomson in Glasgow Med. Journ., 1858; Gibson and Malet, Journ. Anat. xiv. 1; Turner, *ib.* 103.)

Two small nodules of bone, *ossa suprasternalia*, have been found in some rare cases at the sides of the incisura close to the clavicular notches, united by cartilage and ligament to the sternum. Their position is indicated by the asterisks (**) in figure 26, E. They appear to be vestiges of the episternal bone of monotremata and lizards, the lateral parts of which are represented normally in the interarticular fibro-cartilages of the sterno-clavicular articulations. (Breschet, Ann. des Sc. Nat., 2nd series, x. 91; Luschka, "Die Halsrippen und die Ossa suprasternalia," Vienna, 1859; Gegenbaur, Jenaische Zeitschr. i. 175. Bardeleben, Jenaische Sitzungsberichte, 1879, s. 146.)

## THE RIBS.

The **ribs** (*costæ*), twelve in number on each side, constitute a series of arched and highly elastic bones, which extend outwards and forwards from the vertebral column, and form the lateral walls of the thorax. Their anterior extremities give attachment to cartilaginous prolongations—the *costal cartilages*, the first seven pairs of which pass forward to the sternum. On this account the first seven pairs of ribs are called *sternal*, and the remaining five pairs *asternal* ribs. Of these asternal ribs each of the upper three has its cartilage attached along its superior border to the cartilage of the rib above it, while the two last, being entirely free from such attachment, are called *floating* ribs.

**General characters of the ribs.**—These are best marked in the ribs near the middle of the series. The posterior extremity is thickened, and is termed the *head* or *capitulum*; it presents a superior and an inferior oblique articular surface for articulation with the bodies of two vertebræ, and, between them, a slight ridge, to which the interarticular ligament is attached. At a little distance from the head, and separated from it by the slightly constricted *neck*, is the *tubercle*, which is directed backwards, and presents a smooth surface for articulation with the transverse process of the inferior of the two vertebræ with which the head is connected, and, outside that, a roughness marking the insertion of the posterior costo-transverse ligament. The whole extent beyond the tubercle constitutes the *body*. It is laterally compressed, and broader from above downwards towards the anterior extremity. Outside the tubercle, over the most convex part of the body, is a rough line which corresponds to the outer border of the erector spinæ muscle, and marks the *angle*, so-called because at this point the rib takes a more sudden curve, its direction being now forwards and outwards. The inferior border presents on its inner aspect the *subcostal groove*, in which lie the intercostal vessels and nerve, and which is best marked opposite the angle and disappears in front. The anterior extremity is hollowed at its tip into an oval pit, in which the costal cartilage is implanted.

Fig. 23.

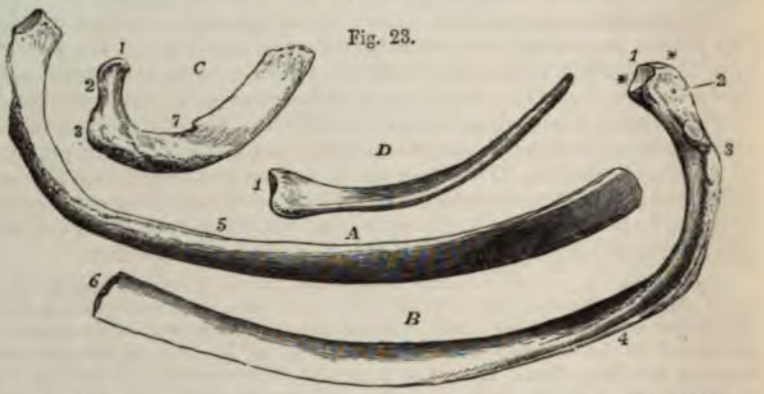

Fig. 23.—THE FIRST, SIXTH, AND TWELFTH RIBS OF THE RIGHT SIDE. (A. T.) ⅓

A, the sixth seen from above and the outer side; B, the same rib from below and within; C, the first rib from above; D, the twelfth rib from above.

1, the head in C & D, the intervertebral ridge in B; **, the costo-central facets; 2, neck; 3, tubercle, in B presenting the rough tubercle and the smooth facet for articulation with the transverse process; 4, lower border with the ridge and subcostal groove; 5, upper border; 6, oval pit for the attachment of the costal cartilage; 7, in C, the scalene tubercle, and behind it the smooth groove for the subclavian artery.

*Inclination and curves.*—There is a general inclination of the ribs downwards from the head to the anterior extremity, the slope being greatest between the head and angle. The curve of the ribs is more marked towards the back part than in front, especially near the angle. Besides the main curves now mentioned the rib is slightly twisted on itself, so that while its surfaces are vertical behind, they are placed somewhat obliquely in front.

**Special characters of certain ribs.**—The ribs increase in length from the first to the seventh or eighth, and decrease to the twelfth, so that the last is little longer, often even shorter, than the first. The first rib is the broadest, and after it the middle ones; the twelfth is the narrowest. The distance of the angle from the tubercle increases gradually from above down.

The **first rib** is not twisted, and is so placed that its surfaces look nearly upwards and downwards. The head is small, and presents a single articular surface for the first dorsal vertebra. The neck is slender, and the angle coincides with the tubercle. On the superior surface are two very slight smooth depressions with an intervening rough mark, and a considerable rough surface behind. The rough surface marks the attachment of the scalenus medius muscle, the posterior depression the position of the subclavian artery, the anterior depression the subclavian vein; and the intervening slight elevation, frequently terminating in a sharp spine on the inner edge—the *scalene tubercle*—indicates the attachment of the scalenus anticus muscle.

The **second rib**, longer than the first, presents externally a prominent roughness which marks the attachment of the serratus magnus.

The **eleventh** and **twelfth ribs** have no tubercle, and only a single articulating surface on the head. The subcostal groove is scarcely perceptible on the eleventh, and is absent, together with the angle, from the twelfth.

*Varieties.*—The number of the ribs is sometimes increased to thirteen on one or both sides. The supernumerary rib is usually very short, and is most frequently formed in connection with the transverse process of the first lumbar vertebra, or occasionally with the seventh cervical: in the latter case the additional rib has generally a double attachment, viz., to the body and transverse process of the vertebra outside a vertebrarterial foramen (see fig. 21, 4, *v*, *v*, and 8, *co.*)

The **costal cartilages** unite the ribs to the sternum. Their breadth diminishes gradually from the first to the last, whilst their length increases as far as the seventh, after which they become gradually shorter. Their line of direction varies considerably. The first descends a little, the second is horizontal, and all the rest, except the last two, ascend more and more from the rib towards the sternum as they are situated lower down. The external or costal extremity, convex and uneven, is implanted into and united with the end of the corresponding rib. The internal extremities of the upper seven (except the first) are smaller than the external, somewhat pointed, and fit into the corresponding angular surfaces on the side of the sternum, with which they are articulated in synovial cavities. Each of the cartilages of the first three asternal ribs becomes slender towards its extremity, and is attached to the lower border of that which is next above it. The last two are pointed and unattached. The sixth, seventh, eighth, and ninth cartilages form a series of interchondral articulations, by means of a broad process sent down from the rounded angle of the one meeting a less salient projection from the upper border of the next.

The first cartilage, which is directly united to the sternum without articular cavity, usually becomes more or less ossified in the adult male; and the others likewise exhibit a considerable tendency to ossify in advanced life. This tendency is not so great in the female, in whom costal respiration is generally more extended than in the male.

### THE THORAX AS A WHOLE.

The bony thorax is of a somewhat conical shape, flattened from before back, and much longer behind than in front. The posterior wall, formed by the dorsal vertebræ and the ribs, is convex from above down, and, the ribs being directed backwards from the vertebræ as far as their angles, a broad furrow is produced on each side of the spine which lodges the erector spinæ muscle. The anterior wall, formed by the sternum and costal cartilages, is only slightly convex, and is inclined at an angle of

20° to 25° with the vertical. In the condition of expiration the upper border of the sternum is opposite the disc between the second and third dorsal vertebræ, the junction of the manubrium and body opposite the middle of the fifth dorsal vertebra, and the xiphi-sternal articulation about opposite the interspace between the ninth and tenth dorsal vertebræ.

Fig. 24.

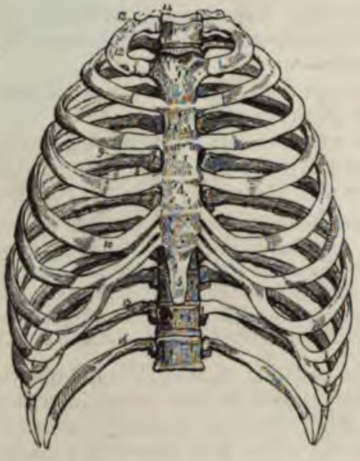

Fig. 24.—FRONT VIEW OF THE THORAX, SHOWING THE STERNUM, COSTAL CARTILAGES, RIBS, AND DORSAL VERTEBRÆ. $\frac{1}{5}$

1, manubrium ; 2, is close to the place of union of the first costal cartilage ; 3, clavicular notch ; 4, body of the sternum ; 5, ensiform process ; 6, groove on the lower border of the ribs ; 7, the vertebral end of the ribs ; 8, neck ; 9, tubercle ; 10, costal cartilage ; 12, first rib ; 13, its tubercle ; 14, first dorsal vertebra ; 15, eleventh, 16, twelfth rib.

The sides are sloped outwards to about the ninth rib, are slightly convex from above down, and strongly arched from before back. The upper aperture is contracted, reniform, nearly plane, and much sloped downwards ; the lower is irregular, the margin ascends on each side from the tenth rib to the xiphi-sternal articulation, and thus gives rise to the *subcostal angle* into the centre of which the ensiform process projects. The form of the cavity corresponds generally to that of the exterior, but in the middle line the antero-posterior diameter is much reduced by the projection of the bodies of the vertebræ ; as a consequence of this and the backward direction of the hinder ends of the ribs, a deep hollow is formed on each side, into which the posterior portions of the lungs are received, and thus the weight of the body is thrown farther back and is more equally distributed around the vertebral column.

The intercostal spaces are eleven in number, somewhat wider above than below, but varying with the elevation or depression of the ribs.

### OSSIFICATION OF THE RIBS AND STERNUM.

The ossification of the ribs begins in cartilage posteriorly about the eighth week of fœtal life, and extends rapidly forwards, so as to reach the permanent

Fig. 25.

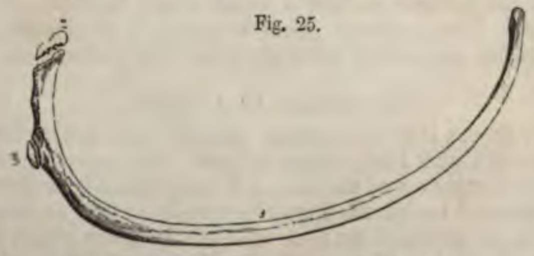

Fig. 25.—ONE OF THE MIDDLE RIBS AT ABOUT TWENTY YEARS OF AGE. (R. QUAIN.)
1, body; 2, epiphysis of the head ; 3, that of the tubercle.

cartilage about the fourth month. After puberty the centres of two small epiphyses appear in the cartilage of the head and tubercle. These become united with the main bone by the twenty-fifth year. The tubercular epiphysis is wanting in the eleventh and twelfth.

The ossification of the sternum begins about the sixth month, and usually by a single centre in the presternum. The next centre appears at the seventh month in the upper segment of the mesosternum, and ossification follows in the next two segments shortly before birth. In the lower segment ossification begins in the first year or later, in the metasternum usually not before the sixth year. and often much later. In the presternum sometimes two centres of ossification appear, one above the other, and occasionally several are met with. In the upper segment of the mesosternum the centre is most commonly single, but in each of the following segments there are frequently two placed one on each side of the middle line. The lower segments of the mesosternum unite together after puberty, but the upper one often remains separate till after the twenty-fifth year. The metasternum is united to the mesosternum in middle life, the presternum in more advanced life, and then not invariably. The bony parts formed from the lateral centres of the lower segments of the mesosternum, as well as of the metasternum, not unfrequently remain separate for a considerable time, and occasionally, by defect of ossification or non-union across the middle line, leave the permanent median aperture referred to on p. 27.

Fig. 26.

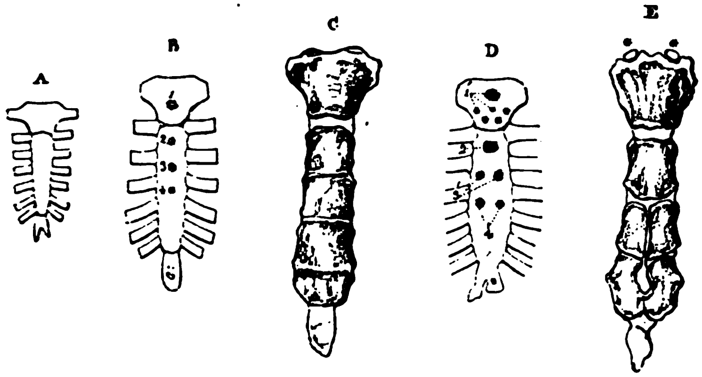

Fig. 26.—Ossification of the Sternum. (R. Quain.)

A, the cartilaginous sternum before the middle of fœtal life.

B, the sternum of a child at birth. 1, 2, 3, & 4, mark the commencing ossific nuclei for the manubrium and three upper pieces of the body.

C, the sternum soon after puberty, showing cartilage between the manubrium and body, and imperfect union of the first, second and third pieces of the body, while the third and fourth are united.

D, a sternum at birth with an unusual number of ossific centres, six in the manubrium, 1', which is very uncommon ; two pairs in the lower pieces of the body 3' & 4' which is not unusual ; 2, the single centre of the first piece of the body.

E, example of the perforated sternum, which depends upon the imperfect union of the pairs of ossific nuclei shown in D in the lower part of the body ; this figure also shows two episternal bones, * *. C and E are reduced below the size of nature.

## III.—THE BONES OF THE HEAD.

The skull, comprising the bones of the head, is of a spheroidal figure, compressed on the sides, broader behind than before, and supported on the vertebral column. All its bones, with the exception of the lower jaw, are immoveably united together by lines and narrow surfaces, more or less uneven, termed *sutures*. The skull is divided by anatomists into two parts, the *cranium* and the *face*. The cranium protects the brain; the face surrounds the mouth and nasal passages, and completes with the cranium the orbits or cavities for the eyes. The cranium is composed of eight bones, viz.: the *occipital*, two *parietal*, the *frontal*, two *temporal*, the *sphenoid*, and the *ethmoid*. The face is composed of fourteen bones, of which twelve are in pairs, viz.: the *superior maxillary*, *malar*, *nasal*, *palate*, *lachrymal*, and *inferior turbinate bones*; and two single, viz.: the *vomer*, and the *inferior maxilla*. The *hyoid bone*, suspended by ligaments from the under surface of the cranium, may also be classed with the bones of the head.

### THE OCCIPITAL BONE.

The **occipital bone** is situated at the lower and back part of the cranium. In general form it is rhomboidal, and through its lower and anterior part passes a large oval aperture, *foramen magnum*, forming the communication between the cranium and spinal canal. The portion of the bone behind the foramen is *tabular*, the narrower part in front forms a thick mass named *basilar process*, and the parts on the sides of the foramen, bearing the condyles or articulating processes by which the head is supported on the atlas, are the *condylar portions*.

Fig. 27.

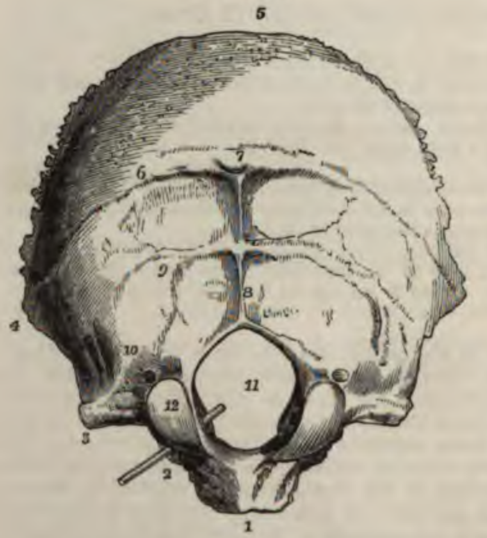

Fig. 27.—Occipital bone from below and behind, showing the external surface. (A. T.) ½

1, basilar process; 2, condylar portion, the probe marks the anterior condylar foramen; 3, jugular process; 4, lateral angle; 5, superior angle; 6, superior curved line; 7, external occipital protuberance; 7, 8, external occipital crest; 9, 10, inferior curved line; 11, foramen magnum; 12, condyle, immediately above it the posterior condylar foramen.

The two superior borders are deeply serrated, and are articulated with the parietal bones in the lambdoid suture. By its two inferior borders, which are uneven but not deeply serrated, it articulates with the mastoid and petrous portions of the temporal bone, while the extremity of its basilar process is united to the body of the sphenoid, in the young condition by cartilage, but after the age of twenty years by continuous osseous substance. The rhomboidal form generally given by the meeting of these borders at the four angles is not unfrequently somewhat changed to the octagonal, by the greater or less projection of subordinate obtuse angles between the upper and lateral, and between the lateral and lower angles.

Fig. 28.

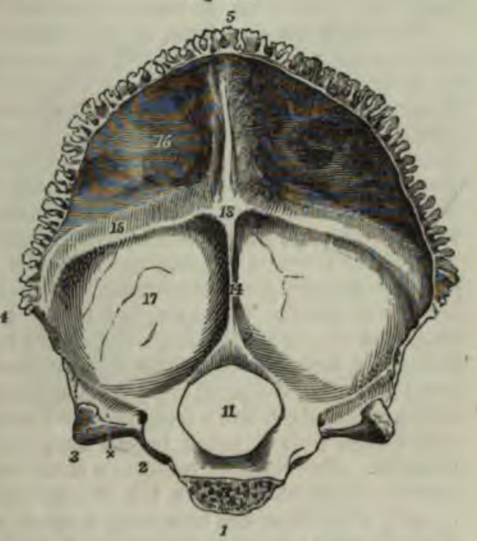

Fig. 28. — Occipital bone from before, showing the internal surface. (A. T.) ½

1, basilar process sawn through at the place of union with the sphenoid bone; 2, condylar portion; 3, jugular process; ×, between 2 & 3, groove of the lateral sinus and jugular notch; 4, lateral angle; 5, superior angle; 1 to 3, the edge of articulation with the petrous bone; 3 to 4, with the mastoid bone; 4 to 5, with the parietal bone; 11, foramen magnum; 13, internal occipital protuberance and groove of the torcular Herophili; 14, internal occipital crest; 15, groove of the lateral sinus; from 5 to 13, groove of the superior longitudinal sinus; 16, cerebral fossa; 17, cerebellar fossa.

The **tabular portion,** or **supraoccipital,** on its *posterior surface* presents about the centre a prominence, varying greatly in its development in different skulls, the *external occipital protuberance,* which can be felt under the skin at the back of the head; arching outwards from this on each side is the *superior curved line,* which divides the surface into two parts, an upper and a lower: the upper part is convex and smooth, and is covered by the hairy scalp; the lower is more uneven; it is divided into two lateral portions by a median ridge called the *external occipital crest,* and each of these is again divided into an upper and a lower surface by the *inferior curved line,* which can be followed outwards to the extremity of the jugular process. The curved lines and the areas thus marked out give attachment to the numerous muscles of the back of the neck.

The *deep surface* of the bone is marked by two smooth ridges which cross one another, one extending from the upper angle to the foramen magnum, and the other transversely from one lateral angle to the other; at the point of intersection of these ridges is the *internal occipital protuberance.* Separated by these ridges are four hollows, the *superior* and *inferior occipital fossæ,* which lodge respectively the posterior cerebral and the cerebellar lobes. The superior part of the longitudinal and the transverse ridges are grooved in the course of the longitudinal and lateral venous sinuses respectively. The wider space where the longitudinal groove is continued into one of the lateral grooves (more frequently the right) by side of the internal occipital protuberance lodges the torcular Herophili. The inferior ridge is single, and is named the *internal occipital crest*. The margins of the tabular portion are deeply serrated above the lateral angles for articulation with the parietal bones; below that level, they unite with the mastoid portions of the temporal bones.

The **condylar portions**, or **exoccipitals**, bear the articulating condyles on their lower part close to the margin of the foramen magnum in its anterior half. The condyles are elliptical and converge somewhat in front; their surfaces are convex from behind forwards and from side to side, and somewhat everted. On the inner side of each is a rough impression for the attachment of the lateral odontoid ligament of the axis. Perforating the bone at the base of the condyle is the *anterior condylar foramen*, running from the interior of the cranium immediately above the foramen magnum outwards and forwards, and transmitting the hypoglossal nerve; the foramen is occasionally double. Behind the condyle is a pit, *posterior condylar fossa*, containing usually the *posterior condylar foramen;* this gives passage to a vein, but it varies greatly in size, and is often absent on one or both sides. Externally to the condyle is a projecting portion of bone known as the *jugular process;* this lies over the transverse process of the atlas, is continuous posteriorly with the tabular part, whilst anteriorly it has a free excavated margin, the *jugular notch*, which contributes, with a notch in the temporal bone, to form the jugular foramen. Its extremity presents a small irregular surface, which articulates by synchondrosis with the petrous part of the temporal bone, and in early adult life enters into osseous union with that. The upper surface of the jugular process is marked by a deep groove for the lateral sinus leading to the jugular notch, and here is seen the inner opening of the posterior condylar foramen; the under surface is rough for the insertion of the rectus capitis lateralis muscle.

**The basilar process,** or **basioccipital,** projects forwards and upwards in the middle of the base of the skull. It increases in thickness and diminishes in breadth towards its extremity. On the inferior surface in the mid-line is a small elevation, *pharyngeal tubercle*, for the attachment of the fibrous raphé of the pharynx, and on each side of this are impressions for the rectus capitis anticus major and minor muscles. Its superior surface presents a smooth depression, the *basilar groove*, which supports the medulla oblongata, and close to each lateral margin a shallow groove for the inferior petrosal sinus.

### THE PARIETAL BONE.

The **parietal bones** form a considerable part of the roof of the skull. They have the shape of quadrilateral plates, convex externally, concave internally. They are a little broader and thicker above than below; the anterior inferior angle is the most projecting. They articulate with each other in the middle line, with the frontal bone anteriorly, the occipital posteriorly, and the temporal and sphenoid below.

On the *outer surface*, near its middle, a more marked convexity exists forming the *parietal eminence*. Below this is the curved *temporal line*, bounding an area somewhat flatter than the rest, *temporal surface*, which forms part of the temporal fossa. Close to the upper border, and nearer to the posterior angle, is the small *parietal foramen*.

The *inner surface* is concave, the deepest part, opposite the parietal eminence, being known as the *parietal fossa;* it is marked by shallow depressions corresponding with the convolutions of the brain, and by narrower furrows branching upwards and backwards from the lower border for the middle meningeal vessels. The largest of these grooves running from the anterior inferior angle is sometimes converted into a canal for a short distance. A slight depression along the inner part of the superior border forms, with the one of the opposite side, the groove of the longitudinal sinus; and a depression at the posterior inferior angle forms a small part of the groove of the lateral sinus. Near the upper border there are in most skulls, but particularly in those of old persons, small irregular pits, lodging the Pacchionian bodies.

Fig. 29.

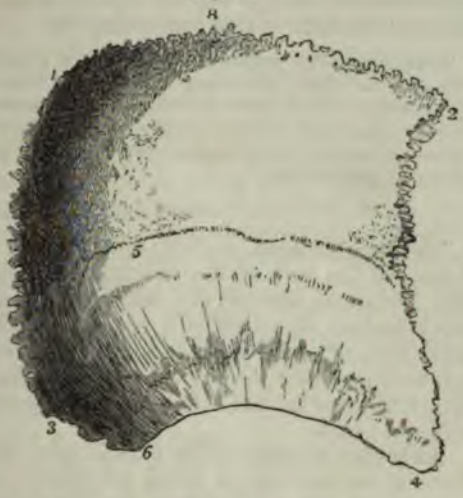

Fig. 29.—External surface of the right parietal bone. (A. T.) ½

1, posterior superior angle; 2, anterior superior angle; 3, posterior inferior angle; 4, anterior inferior angle, articulating with the great wing of the sphenoid bone; from 1 to 2, superior border in the sagittal suture; from 2 to 4, anterior border in the coronal suture; from 1 to 3, posterior border in the lambdoid suture; from 4 to 6, margin of the squamous suture; from 3 to 6, margin articulating with mastoid; 5, temporal line above which is the parietal eminence; 8, parietal foramen.

Fig. 30.

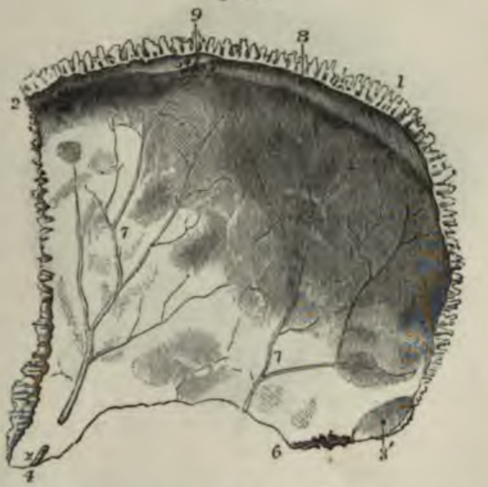

Fig. 30.—The parietal bone from the inside. (A.T.) ½

1, 2, 3, 4, 6, & 8, indicate the same parts as in the last figure: between 1 & 2 the half groove of the superior longitudinal sinus; 3′, groove of the lateral sinus; 7, the ramified grooves of the meningeal vessels; above × the groove is converted into a canal; 9, the irregular pits for the Pacchionian bodies.

*Borders.*—The anterior, superior, and posterior borders are deeply serrated. The inferior border presents in the greater part of its extent a sharp or squamous edge, with a slightly fluted surface directed outwards and overlapped at its anterior extremity by the great wing of the sphenoid, and behind that by the squamous part of the temporal bone; its posterior part is serrated, and articulates with the mastoid portion of the temporal. The anterior border is slightly overlapped by the frontal bone above, but overlaps the edge of that bone inferiorly.

**Varieties.**—The parietal foramen varies greatly; frequently it is absent on one or both sides; in extreme cases it has been seen more than half an inch in diameter. As a rare occurrence the parietal bone is divided by a suture into an upper and a lower part. Considerable depressions sometimes occur on the outer surface, in which the bone is not thicker than paper; usually on both sides and symmetrical.

### THE FRONTAL BONE.

The **frontal bone,** arching upwards and backwards above the orbits, forms the fore part of the cranium; it likewise presents inferiorly two thin horizontal laminæ, the *orbital plates*, which form the roofs of the orbits and are separated by a mesial excavation, the *ethmoidal notch*. It articulates with twelve bones, viz., posteriorly with the parietals and sphenoid; outside the orbits with the malars; and between the orbits, from before backwards, with the nasal, superior maxillary, lachrymal, and ethmoid bones.

**Anterior surface.**—The part forming the greatest convexity of the forehead on each side is called the *frontal eminence*. It is separated by a slight depression below from the *superciliary ridge*, a curved elevation of varying prominence above the margin of the orbit. Between the superciliary ridges is the surface called *glabella*. The margin of the orbit, the *orbital arch*, is most defined towards its outer part; it presents towards its inner third the *supraorbital notch*, sometimes a foramen, which transmits the supraorbital nerve and artery. The extremities of the orbital arch point downwards, and form the *internal* and *external angular processes*. The internal is but slightly marked, it meets the lachrymal bone; the external is strong and projecting, and articulates with the malar bone. The *temporal crest* springs from the external process, and arches upwards and backwards to be continued into

Fig. 31.

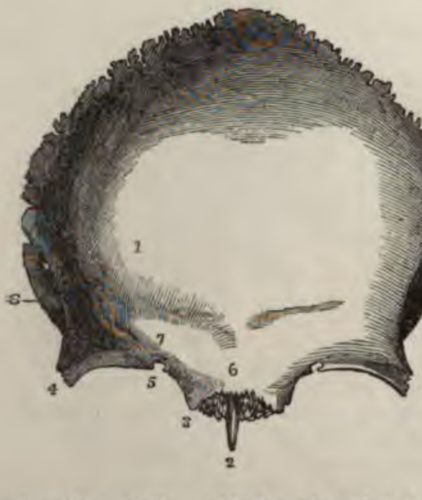

Fig. 31.—Frontal bone from before, showing its external surface. (A. T.) ½

1, frontal eminence; 2, nasal spine, and above this the serrated surface for articulation of the nasal and superior maxillary bones; 3 to 4, orbital arch—3, internal, and 4, external angular process; 5, supraorbital notch; 6, glabella; 7, superciliary ridge; 8, temporal crest, and behind this the temporal surface.

the temporal line of the parietal bone: it separates the temporal from the frontal part of the outer surface of the bone.

**Inferior surface.**—The orbital surfaces are somewhat triangular, their internal margins being parallel, while the external are directed backwards and inwards. Close to the external angular process is the *lachrymal fossa*, which lodges the lachrymal gland; and close to the internal angular process is a small depression, *trochlear fossa*, where the pulley of the superior oblique muscle is attached. Between the orbits in front is the *nasal notch*, a semilunar serrated surface which articulates with the superior maxillary and nasal bones; in the concavity of the notch a sharp process of variable length, the *nasal spine*, descends in the middle line between the latter bones and the central plate of the ethmoid, and on each side of this is a small grooved surface which enters into the formation of the roof of the nasal fossa. Between the ethmoidal notch and the inner margin of the orbit is an irregular surface occupied by depressions forming the roofs of cells in the ethmoid bone. Traversing this surface are two grooves, which complete, with the ethmoid, the *anterior* and *posterior internal orbital canals*; the anterior transmits the nasal nerve and the anterior ethmoidal vessels; the other, the posterior ethmoidal vessels. Further forward, on each side of the nasal spine, is the opening of the *frontal sinus*, a cavity which extends within the bone for a variable distance behind the superciliary ridges. Outside and behind the orbital surface, there is a large rough triangular area which articulates with the great wing of the sphenoid.

**Cerebral surface.**—This surface forms a large concavity, except over the roofs of the orbits, which are convex. Upon it are seen the impressions of the cerebral convolutions, which, with the intervening ridges, are strongly marked over the orbits. A groove, the *frontal sulcus*, lodging the longitudinal sinus, descends from the middle of the upper margin of the bone, and is succeeded by the *frontal crest*, a ridge which runs down to the lower margin. A small foramen, usually formed in part by the central plate of the ethmoid,

Fig. 32.

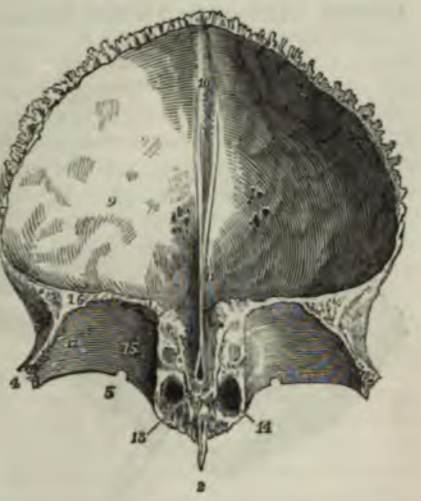

Fig. 32.—THE FRONTAL BONE FROM BEHIND AND BELOW, SHOWING THE INTERNAL CEREBRAL SURFACE AND THE ROOF OF THE ORBITS. (A. T.) ½

2, 4, and 5, as in the preceding figure; 9, internal or cerebral surface; 10, groove of the superior longitudinal sinus, ending below in 11, the frontal crest, which leads down to 13, the foramen caecum; 12, orbital plate, the number is placed in the depression for the lachrymal gland; 14, opening of the frontal sinus; 15, placed on the roof of the orbit internally, is near the opening of the anterior internal orbital canal; 16, surface of articulation with great wing of sphenoid.

is situated at its base; it is known as the *foramen cæcum*, but may transmit a minute vein from the nasal fossæ. The upper and greater part of the edge encompassing the cerebral surface of the bone is serrated, and articulates with the parietal bones in the coronal suture in the manner before described; the lower transverse part is thin and uneven, and articulates with the greater and lesser wings of the sphenoid. The adult frontal bone is frequently divided into two parts by a median suture, the *frontal* or *metopic* suture which may be regarded as the persistence of the original fœtal condition; a trace of this suture is to be seen even in the oldest skulls above the root of the nose.

### THE TEMPORAL BONE.

The **temporal bone** takes part in the formation of the side and base of the skull, and contains in its interior the organ of hearing. It is usually described in three parts, viz., an expanded anterior and superior part, the *squamous* portion including the zygomatic process, a thicker posterior portion, the *mastoid*, and below and between these the *petrous* portion, a three-sided pyramid, exhibiting at its base externally the aperture of the ear, and projecting forwards and inwards into the base of the skull.

It articulates posteriorly and internally with the occipital bone, superiorly with the parietal, anteriorly with the sphenoid, by the zygomatic process with the malar, and by the glenoid cavity with the inferior maxillary bone.

The **squamous portion**, or squamo-zygomatic, extends forwards and upwards from its connection with the other portions, and presents superiorly an arched border which describes about two-thirds of a circle.

The *inner surface* is marked by cerebral impressions, and by meningeal grooves. At its upper border the outer table is prolonged considerably beyond the inner, forming a thin scale with the fluted surface looking inwards and overlapping the corresponding bevelled edge of the parietal bone. But in front the border is thicker, looks forwards and inwards, and is serrated for articulation with the great wing of the sphenoid.

Fig. 33.

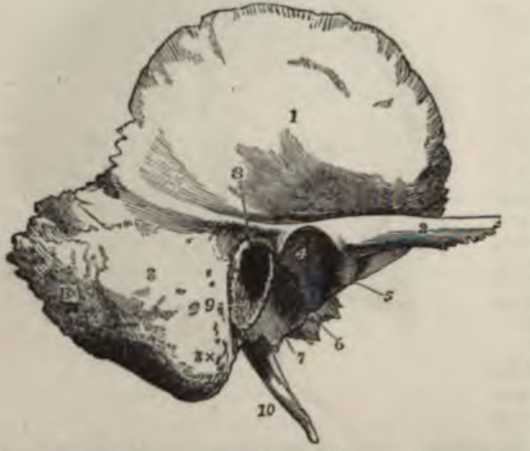

Fig. 33.—Right temporal bone from the outside. (A. T.) ⅔

1, squamous part; 2, zygoma; 3, mastoid part, 3 ×, mastoid process; 4, articular part of the glenoid fossa; 5, articular eminence at the root of the zygoma, and above it the tubercle; 6, fissure of Glaser; 7, tympanic plate forming the posterior non-articular part of the glenoid fossa, terminating inferiorly in the vaginal process; 8, external auditory meatus; 9, auditory process; 10, styloid process; 13 ×, mastoid foramen.

The *outer surface* is in its greatest extent vertical, with a slight convexity, and forms part of the temporal fossa. From its lowest part a long process, the zygoma, takes origin.

Fig. 34.

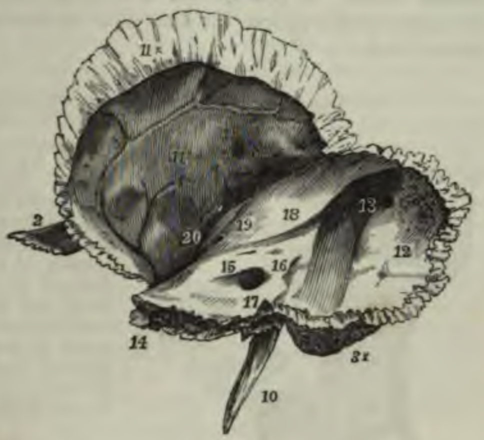

Fig. 34.—THE RIGHT TEMPORAL BONE FROM THE INNER SIDE. (A. T.) $\frac{2}{3}$

2, 3×, 10, as in the preceding figure. 11, cerebral surface of the squamous portion; 11×, the squamous edge; 12, inner surface of the mastoid portion; 13, sigmoid groove of the lateral sinus—the figure is placed at its upper part, and close to the mastoid foramen; 14, apex of the petrous bone; 15, internal auditory meatus; 16, scale of bone covering the aqueduct of the vestibule; 17, is above the aqueduct of the cochlea; 18, superior petrosal groove; 19, eminence of the superior semicircular canal; 20, hiatus Fallopii.

The *zygoma*, or zygomatic process, is connected with the lower and outer part of the squamous portion, and is of considerable breadth at its base, which projects outwards. It then turns forwards, becomes narrower, and is twisted on itself so as to present outer and inner surfaces and upper and lower borders. The superior margin is thinner, and prolonged further forward than the inferior. The bevelled extremity is serrated, and articulates with the malar bone. At its base the zygoma presents two roots; the *anterior*, continuous with the lower border, is a broad convex ridge, directed inwards on the under aspect of the bone; the *posterior*, prolonged from the upper border, passes backwards above the external auditory meatus, marks the line of division between the squamous and mastoid portions of the bone, and turning upwards posteriorly forms the boundary of the temporal fossa. At the point of division of the two roots is a slight tubercle, which gives attachment to the external lateral ligament of the lower jaw. Between the two roots is the *glenoid fossa*, a considerable hollow, elongated from without inwards, and divided into two parts by the nearly transverse *fissure of Glaser*. The posterior part of the glenoid fossa is formed by the tympanic plate of the petrous division of the bone, is non-articular, and lodges a portion of the parotid gland; the anterior part of the fossa, together with the cylindrical elevation, *articular eminence*, formed by the anterior root of the zygoma in front of it, is coated with cartilage, and forms the concavo-convex surface for articulation with the lower jaw; the articular cavity is bounded behind by a small conical process which descends in front of the external auditory meatus, and is known as the *postglenoid process*. In front of the articular eminence, and separated from the temporal surface by a slight ridge, is a small triangular area which enters into the zygomatic fossa.

The **mastoid portion** is rough externally for the attachment of muscles, and is prolonged downwards behind the aperture of the ear into a nipple-shaped projection—the *mastoid process*. This process has on its inner side a deep groove, the *digastric fossa*, which gives attachment to the digastric muscle; and internal to that is the slight *occipital groove*, for the occipital artery. The internal surface of the mastoid portion is marked by a deep sigmoid depression, which is part of the groove of the lateral sinus. A passage for a vein, of very variable size, the *mastoid foramen*, usually pierces the bone near its posterior margin, and opens into the groove.

Fig. 35.

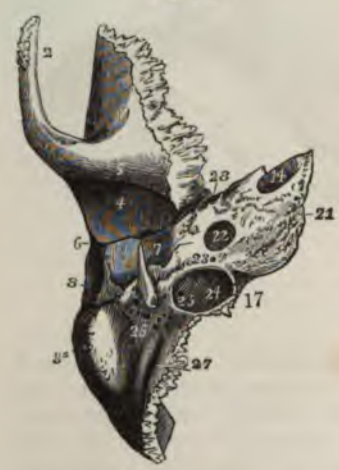

Fig. 35.—THE RIGHT TEMPORAL BONE FROM BELOW. (A. T.) $\frac{2}{3}$

2, 3, 3×, 4, 5, 6, 7, 8, as in the preceding figures. 14, is at the apex of the petrous bone in the upper opening of the carotid canal; 17, aqueduct of the cochlea; 21, lower rough surface of the petrous bone; 22, the lower opening of the carotid canal; 23, the small foramen of Jacobson's nerve; 24, the jugular fossa, and within it, 25, the foramen of Arnold's nerve; 26, stylo-mastoid foramen—the figure is placed in the anterior part of the digastric fossa; 27, groove of the occipital artery; 28, place of the anterior opening of the osseous Eustachian canal.

The **petrous portion** is named from its hardness. It contains the organ of hearing. It forms a three-sided pyramid, with its base directed outwards, one surface looking downwards, and the other two turned towards the interior of the skull.

*Inferior surface, base, and apex.*—At the base is the aperture of the ear. It forms a short canal, the *external auditory meatus*, directed inwards and a little forwards, narrower in the middle than at its extremities, and leading into the cavity of the *tympanum*, part of which is seen from the exterior in the macerated bone. It is bounded superiorly by the posterior root of the zygoma, and in the remainder of its circumference chiefly by the *external auditory process*, a curved uneven border, to which the cartilage of the ear is attached. This process is the thickened outer extremity of the *tympanic plate*, a lamina one surface of which forms the anterior and inferior wall of the external auditory meatus and the tympanum, while the other looks towards the glenoid fossa. The upper margin of the tympanic plate is separated from the squamous by the *fissure of Glaser*, while its lower margin descends as a sharp edge, the *vaginal process*, which partly surrounds the styloid process at its base. The *styloid process* is long and tapering, and is directed downwards and forwards. It is placed in front of the digastric fossa, and has immediately behind it the foramen which forms the outlet of the canal of the facial nerve, named *stylo-mastoid* from its position between the styloid and mastoid processes. Internal to the stylo-mastoid foramen is a small irregular surface, *jugular facet*, which articulates by synchondrosis with the jugular process of the occipital bone. In front of this comes a smooth and deep depression, the *jugular fossa*, which forms with the jugular notch of the occipital bone the jugular foramen. In front of the jugular

*carotid foramen*, the inferior extremity of the carotid canal;

and internal to the carotid foramen is a rough free surface which is continued into the inner extremity, or *apex* of the petrous bone. The *carotid canal* ascends at first perpendicularly, then turns horizontally forwards and inwards, and emerges at the apex, close to the anterior margin; it transmits the internal carotid artery.

The *posterior surface* looks backwards and inwards, and forms part of the posterior fossa in the base of the skull. It presents a large orifice leading into a short canal which is directed outwards, the *internal auditory meatus*. This canal is terminated by a plate of bone, the *lamina cribrosa*, presenting in the lower part small apertures through which the divisions of the auditory nerve pass, while in its upper part is the commencement of the canal called *aqueduct of Fallopius*, which transmits the facial nerve. This canal takes a somewhat circuitous course through the petrous bone, passing outwards and backwards over the labyrinth of the ear, and then downwards to terminate at the stylo-mastoid foramen.

The *anterior* or *upper surface* looks upwards and forwards, and forms part of the middle fossa in the base of the skull. A depression near the apex marks the position of the Gasserian ganglion. A narrow groove runs obliquely backwards and outwards to a foramen named the *hiatus Fallopii*, which leads to the aqueduct of Fallopius, and transmits the large superficial petrosal nerve. Farther back is a rounded eminence, indicating the situation of the superior semicircular canal.

The line of separation of this surface of the petrous from the internal surface of the squamous is always marked by a narrow fissure, *petro-squamous*, commencing anteriorly at the retiring angle between the two portions, and generally to be traced less distinctly to the posterior border of the bone. The portion of bone between this fissure externally and the eminence of the superior semicircular canal and the hiatus Fallopii internally is a thin lamina, often perforated, which roofs in the tympanum and the common canal of the Eustachian tube and tensor tympani muscle, and is known as the *tegmen tympani*.

The *superior border* is grooved for the superior petrosal sinus. The *anterior border* is very short, and forms at its junction with the squamous part an angle in which is situated the orifice of the *Eustachian canal*, the osseous portion of a tube of the same name, which leads from the pharynx to the tympanum; and above this, partially separated from it by a thin lamella, the *processus cochleariformis*, is a small passage which lodges the tensor tympani muscle. The *posterior border* internal to the jugular fossa articulates with the basilar process of the occipital bone, and forms with that the groove for the inferior petrosal sinus.

**Small Foramina.**—The opening of the *aqueduct of the vestibule* is a narrow fissure, covered by a depressed scale of bone, and situated on the posterior surface of the petrous bone, about four lines outside the internal auditory meatus; that of the *aqueduct of the cochlea* is a small foramen, beginning in a three-sided wider depression in the posterior margin, directly below the internal auditory meatus. In the plate between the jugular fossa and the carotid canal is the foramen by which the nerve of Jacobson passes to the tympanum. In the ascending part of the carotid canal is the minute foramen for the tympanic branch of the carotid plexus. In the jugular fossa are a groove and foramen for the auricular branch of the vagus nerve; and parallel to the hiatus Fallopii, close to the canal for the tensor tympani muscle, are a groove and foramen for the small superficial petrosal nerve.

The so-called fissure of Glaser is for the most part closed, but near the inner end a small orifice is left leading to the tympanic cavity, and which contains the slender process of the malleus, the laxator tympani muscle, and the tympanic branch of the internal maxillary artery ; while farther inwards another small canal may be seen by which the chorda tympani nerve issues.

The description of the Small Bones of the Ear with the Tympanum and Internal Ear will be found in the chapter on the Organs of the Senses.

### THE SPHENOID BONE.

The **sphenoid bone** is placed across the base of the skull, near its middle. It enters into the formation of the cavity of the cranium, the orbits, and the nasal fossæ. It is of very irregular shape, and consists of a central part or *body*, a pair of lateral expansions called the *great wings*, a pair of smaller horizontal processes above, called the *small wings*, and a pair which project downwards, the *pterygoid processes*.

Fig. 36.

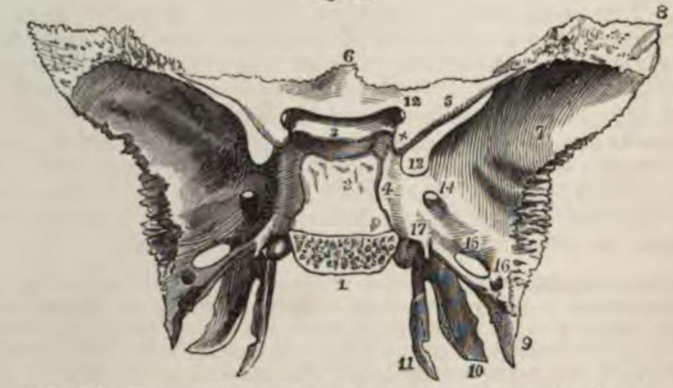

Fig 36.—The sphenoid bone from above and behind. (A. T.) $\frac{2}{3}$

1, the basilar surface, sawn from the occipital bone ; 2, Dorsum sellæ terminating superiorly in the two posterior clinoid processes ; 3, is placed on the olivary eminence, and between it and 2 is the sella turcica, or pituitary fossa ; in front of 3 is the transverse groove of the optic commissure ; 4, the side of the body with the sigmoid groove of the internal carotid artery ; 5, lesser wing ; ×, anterior clinoid process ; 6, ethmoidal spine ; 7, cerebral surface of the great wing ; 8, upper angle of the great wing, which articulates with the parietal bone ; 9, the spinous process ; 10, external, and 11, internal pterygoid plate ; 11, is placed opposite the hamular process and groove for the tendon of the tensor palati muscle ; 12, optic foramen ; 13, sphenoidal fissure ; 14, foramen rotundum ; 15, foramen ovale ; 16, foramen spinosum ; 17, lingula, below which is placed the posterior opening of the Vidian canal.

The sphenoid is articulated with all the seven other bones of the cranium and with five of those of the face, viz., posteriorly with the occipital and with the petrous portions of the temporals, anteriorly with the ethmoid, palate, frontal, and malars, laterally with the squamous portion of the temporals, the parietals and frontal, and inferiorly with the vomer and palate bones ; sometimes also with the superior maxilla.

The **body** is hollowed out into two large cavities, the sphenoidal sinuses, separated by a thin mesial lamina, the *sphenoidal septum*, and opening anteriorly into the nasal fossæ by two rounded apertures. The *superior surface* presents in the middle a deep pit, the *pituitary fossa*, or *sella turcica*, which lodges the pituitary body. In front of the fossa is an [illegible]n of bone on a level with the optic foramina, the *olivary* *eminence*, on which the optic commissure rests in a slight groove; and in front of this is a surface on a slightly higher level, continuous with the superior surfaces of the small wings, and having a slight projection forwards of its anterior border, which articulates with the cribriform plate of the ethmoid, and is called the *ethmoidal spine*. Behind the pituitary fossa is a prominent lamella, the *dorsum sellæ*, the posterior surface of which is sloped upwards and forwards in continuation of the basilar groove of the occipital bone. The angles of this lamella project over the fossa, and are called the *posterior clinoid processes*. On each side of the body the surface descends obliquely to a considerably lower level than the fossa; it presents close to the margin of the fossa a superficial winding groove directed from behind forwards, marking the course of the internal carotid artery. On the outer side of the commencement of this groove, and in the angle between the body and the great wing, there projects the small tongue-like process termed *lingula sphenoidalis*.

The *posterior surface* is united to the basilar process of the occipital bone, in early life by cartilage, but in adult age by continuous bony substance.

The *anterior surface* presents in the middle line the *sphenoidal crest*, a thin projecting edge which descends from the ethmoidal spine, and articulates with the central plate of the ethmoid; the oblong surface on each side of the crest presents a division into a median and a lateral part: the lateral part is irregularly excavated, and articulates with the lateral mass of the ethmoid and the orbital process of the palate bone; the median part is smooth and free, entering into the formation of the roof of the nasal fossa, and presenting near its upper end the rounded orifice of the sphenoidal sinus. The sphenoidal crest terminates inferiorly in the *rostrum*, a sharp vertical prominence continued back some distance on the *inferior* surface, and which fits in between the alæ of the vomer. These last and the vaginal processes of the internal pterygoid plates cover the greater part of the inferior surface of the body.

The **sphenoidal turbinate** or **spongy bones** (*cornua sphenoidalia, bones of Bertin*), form a considerable part of the anterior wall of the body of the sphenoid, bounding the foramen of each sinus. These bones have a triangular form, with the apex directed downwards, and are in the adult usually incorporated with the sphenoid, but as explained in the account of their development, were originally distinct. They are frequently united by earlier or stronger anchylosis with the ethmoid or palate bones, so as to come away, at least in part, with either of these in disarticulation of the skull, and thus lay open the sphenoidal sinuses. A small portion of these bones sometimes appears on the inner wall of the orbit, between the ethmoid, frontal, sphenoid, and palate bones (Cleland in Trans, of Roy. Soc. for 1862).

The **small wings** extend nearly horizontally outwards on a level with the fore part of the superior surface of the body. The extremity of each is slender and pointed, and comes very close to, but usually not into actual contact with, the great wing. The superior surface forms part of the anterior fossa of the base of the cranium, the inferior overhangs the sphenoidal fissure and the back of the orbit. The anterior border, thin and serrated, articulates with the orbital plate of the frontal bone. The posterior border is prominent and free, and forms the boundary between the anterior and middle cranial fossæ, terminating internally in a smooth rounded knob, the *anterior clinoid process*. In front of this is the optic foramen perforating the base of the wing.

The **great wings** project outwards and upwards from the sides of the body. The back part of each is placed horizontally, and occupies the angle between the petrous and squamous portions of the temporal bone; from its pointed extremity it sends downwards a short and sharp projection, the *spinous process.* The upper and fore part is vertical, and three-sided, lying between the cranial cavity, the orbit, and the temporal fossa. The *cerebral surface* of the great wing is concave, and forms part of the middle fossa of the base of the cranium. The *external surface* (temporo-zygomatic) is divided by a ridge, *infratemporal crest,* into an inferior part, which looks downwards into the zygomatic fossa, and an elongated superior part, looking outwards, which forms a part of the temporal fossa. The *anterior surface* looks forwards and inwards, and consists of a quadrilateral *orbital* portion, which forms the back part of the external wall of the orbit, and of a smaller inferior portion which overhangs the pterygoid process, looks into the spheno-maxillary fossa, and is perforated by the foramen rotundum. The *posterior border* in its median part bounds the foramen lacerum, in its lateral part articulates with the petrous, and forms with that a groove on the under aspect for the cartilaginous part of the Eustachian tube. The *external margin* articulates with the squamous, and the extremity overlaps the anterior inferior angle of the parietal. In front of this comes a triangular surface, the sides of which are formed by the upper margins of the cerebral, orbital, and temporal surfaces respectively, for articulation with the frontal bone. The *anterior margin,* between the orbital and temporal surfaces, articulates with the malar bone, and below this is a short horizontal free edge separating the zygomatic and spheno-maxillary surfaces. Above and internally the orbital and cerebral surfaces meet at the sharp border which forms the lower boundary of the sphenoidal fissure.

Fig. 37.

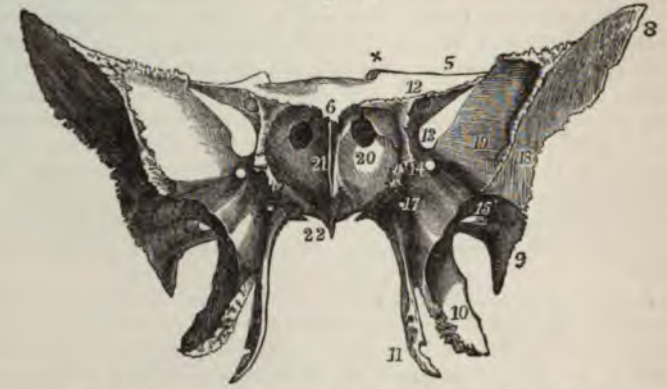

Fig. 37.—THE SPHENOID BONE FROM BEFORE. (A. T.) $\frac{2}{3}$

The indications where marked are the same as in the preceding figure. 17, marks the anterior opening of the Vidian canal; 18, temporal surface of the great wing; 19, its orbital surface; 20, sphenoidal turbinate bone; above 20, the opening into the sphenoidal sinus; 21, sphenoidal crest; 22, rostrum, and above 22, the vaginal process.

The **pterygoid processes** project downwards and slightly forwards, from the adjacent parts of the body and the great wings. Each consists of two plates united in front and diverging behind, so as to enclose between them the *pterygoid fossa*. The *external pterygoid plate*, broader than the internal, lies in a plane extending backwards and outwards; its outer surface bounds the zygomatic fossa, and is impressed by the external pterygoid muscle. The *internal pterygoid plate* is longer and narrower than the external, and is prolonged into the slender hook-like or *hamular process*, round which in a groove plays the tendon of the tensor palati muscle. At its base, the internal plate turns inwards beneath the body, from which its extremity remains distinct as a slightly raised edge, known as the *vaginal process*, which articulates with the everted margin of the vomer; externally to this it is marked by a small groove, which contributes with the palate bone to form the *pterygo-palatine canal*. The interval between the lower ends of the pterygoid plates, *pterygoid notch*, is occupied by the pyramidal process of the palate bone. At the base of the internal pterygoid plate is a slight depression, the *navicular fossa*, which gives attachment to the tensor palati muscle.

**Fissures** and **foramina.**—Each lateral half of the bone presents a fissure, four foramina, and a canal. The *sphenoidal fissure* is the obliquely placed elongated interval between the great and the small wing, closed externally by the frontal bone; it opens into the orbit, and transmits the third, fourth, and sixth nerves, the ophthalmic division of the fifth nerve, and the ophthalmic vein. Above and to the inside of it is the *optic foramen*, which is inclined outwards and forwards from the side of the olivary eminence, pierces the base of the small wing, and transmits the optic nerve and the ophthalmic artery. The *foramen rotundum* is directed forwards through the great wing, below the sphenoidal fissure; it opens immediately below the level of the orbit, and transmits the superior maxillary nerve. The *foramen ovale* is large, placed behind and a little external to the foramen rotundum, near the posterior margin of the great wing; it is directed downwards, and transmits the inferior maxillary nerve. The *foramen spinosum* is a small foramen piercing the great wing, near its posterior angle, and transmits the middle meningeal vessels.

The *Vidian* or *pterygoid canal*, passes through the bone horizontally from before backwards at the base of the internal pterygoid plate; it opens anteriorly into the spheno-maxillary fossa, and posteriorly into the foramen lacerum, and transmits the Vidian nerve and vessels.

**Varieties.**—A small tubercle is often seen on each side in front of the pituitary fossa, at the base of the olivary eminence, and immediately internal to the last part of the carotid groove; this is known as the *middle clinoid process*, and is sometimes connected by a spiculum of bone to the anterior clinoid process. Less frequently the anterior and posterior clinoid processes are similarly united. The outer pterygoid plate may be connected by a bridge of bone or of ligament with the spinous process. The foramen ovale and foramen spinosum are frequently incomplete at the posterior margin of the bone.

### THE ETHMOID BONE.

The **ethmoid,** or sieve-like bone, projects downwards from between the orbital plates of the frontal bone, and enters into the formation of the cranium, the orbits, and the nasal fossæ. It is of a cuboid figure. It is exceedingly light for its size, being composed of very thin plates of bone forming in part irregular cells. It consists of a *central vertical plate*, and of two *lateral masses*, united at their superior extremities by the horizontal *cribriform plate.* It articulates with thirteen bones : the frontal, sphenoid and vomer, the nasal, lachrymal, superior maxillary, palate, and inferior turbinate bones.

The **vertical plate, mesethmoid,** lies in the mesial plane, and forms the upper part of the septum of the nose. Its superior margin appears in the cranial cavity, above the cribriform plate, in the form of a ridge which rises anteriorly into a thick process, the *crista galli,* to which the falx cerebri is attached. The anterior margin of the crista galli is vertical and broad, usually presenting a groove, which completes the foramen cæcum of the frontal bone. Below the level of the cribriform plate, the anterior margin of the vertical plate articulates with the nasal spine of the frontal and with the nasal bones. The inferior margin articulates in front, and sometimes even in its whole extent, with the septal cartilage of the nose ; and in its posterior half, in the adult, it is more or less completely joined by osseous union on one or both sides to the two plates of the vomer. The posterior margin is very thin, and is united to the crest of the sphenoid. This plate presents superiorly a number of grooves and minute canals leading from the foramina of the cribriform plate, for the transmission of the olfactory nerves.

Fig. 38.

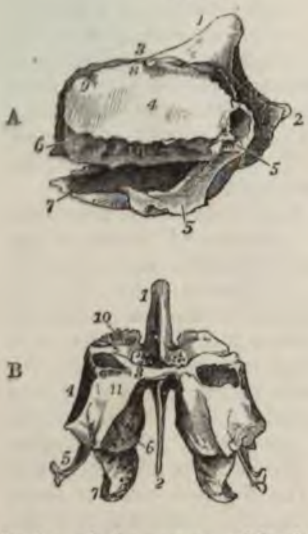

Fig. 38.—The ethmoid bone. (A. T.) $\frac{2}{3}$

A, from the right side. 1, crista galli ; 2, vertical plate ; 3, cribriform plate and foramina ; 4, orbital plate ; 5, 5, uncinate process ; 6, superior, and 7, inferior turbinate process ; 8, groove forming the anterior, and 9, posterior internal orbital canal.

B, from behind. 1 to 7, as in A ; 10, the lateral or cellular part of the bone ; 11, its posterior surface of union with the sphenoidal turbinate and palate bones.

The **lateral masses, ethmoturbinals,** enclose a number of spaces of irregular form, arranged in two sets, the *anterior* and *posterior ethmoidal cells,* which in the recent state are lined with prolongations of the mucous membrane of the nose. On the *external aspect* of each lateral mass is a thin, smooth lamina, of a quadrilateral form, the *orbital plate* or *os planum,* which closes in the ethmoidal cells, and forms a considerable part of the inner wall of the orbit. The circumference of the orbital plate articulates in front with the lachrymal, behind with the sphenoid, above with the frontal, and below with the orbital surfaces of the superior maxillary and palate bones. In front of the orbital plate the lateral mass extends forwards, under cover of the lachrymal bone ; and from this part descends the *uncinate* process, a long thin lamella which curves downwards, outwards and backwards, forming part of the inner wall of the maxillary sinus, and articulating at its extremity with the inferior turbinate bone.

The *internal aspect* of each lateral mass forms part of the external wall of the nasal fossa, and consists of a thin, uneven lamella, connected above with the cribriform plate, and exhibiting a number of canals and grooves for branches of the olfactory nerve. It is divided at its back part by a channel, directed forwards and upwards from its posterior margin to about its middle. This is the *superior meatus of the nose*, and communicates with the posterior ethmoidal cells. The short, sharp margin which overhangs this channel, is the *superior turbinate process* or *spongy bone*. Below this is a slightly folded margin of greater extent, free in front and behind, the *inferior turbinate process* or *middle spongy bone*, which overhangs the *middle meatus of the nose*. From the front of the middle meatus a passage, the *infundibulum*, is prolonged upwards through the anterior ethmoidal cells, into the frontal sinus.

The superior margin of the lateral mass is covered, and the cells completed, by the projecting inner border of the orbital plate of the frontal bone ; two grooves are seen crossing it, which complete with the frontal bone the internal orbital canals. The inferior margin is formed by the rounded edge of the middle turbinate bone, and is free in the nasal fossa. The anterior extremity presents one or two open cells, which are closed by the nasal process of the superior maxilla, and the posterior extremity fits against the front of the body of the sphenoid, where it is commonly anchylosed with the sphenoidal spongy bone.

The **cribriform plate** corresponds in size to the ethmoidal notch of the frontal bone which it occupies. On each side of the crista galli it is depressed into the *olfactory groove* which lodges the olfactory bulb, and is pierced by numerous foramina, for transmission of the filaments of the olfactory nerves. The foramina in the middle of the groove, are simple perforations ; the internal and external sets are the orifices of small canals which subdivide as they descend on the vertical plate and lateral mass. At the anterior extremity is a small fissure at each side of the crista galli, close to its base, and externally to this a groove or foramen, connected usually by a slight furrow with the anterior internal orbital canal, which transmits the nasal branch of the ophthalmic nerve.

### THE SUPERIOR MAXILLARY BONE.

The **upper jaw**, *superior maxilla*, is the principal bone of the face ; it supports all the teeth of the upper range, and takes part in the formation of the hard palate, the floor of the orbit, and the floor and lateral wall of the nasal cavity. It consists of a central part or *body*, and four processes. The body presents an external surface, which is again subdivided into anterior or *facial*, and posterior or *zygomatic* portions ; an internal or *nasal* surface, and a superior or *orbital* surface. The processes are, the *nasal* or *ascending*, projecting upwards from the fore part of the body, the *alveolar* forming the lower border of the bone and containing the alveoli or sockets for the teeth, the *malar* on the outer aspect separating the facial and zygomatic surfaces, and the *palate process* projecting horizontally on the inner side. The body is farther excavated by a large sinus or *antrum*, which opens on the inner side into the nasal fossa. The superior maxillary bone articulates with its fellow, with the nasal, frontal, lachrymal, ethmoid, palate, malar, vomer, and inferior turbinate bones, and sometimes with the sphenoid.

The *facial surface* is marked at the lower part, where it is continuous with the outer surface of the alveolar process, by a series of eminences corresponding in position to the fangs of the teeth ; that of the canine si particularly prominent, and internal to this is a slight depression, the *incisor* or *myrtiform fossa;* while between it and the malar process is the deeper *canine fossa.* Above the canine fossa, and close below the margin of the orbit, is the *infraorbital foramen,* by which the infraorbital nerve and artery issue. The inner margin of this surface is deeply excavated by the *nasal notch,* the sharp edge of which is produced below into the *anterior nasal spine.*

The *zygomatic surface* looks into the zygomatic and spheno-maxillary fossæ; it is convex and presents about the centre one, two or more apertures of the *posterior dental canals,* transmitting the vessels and nerves of that name; the lower and posterior part of this surface is prominent and rough, and is distinguished as the *tuberosity.*

The *nasal surface* presents at the fore part a nearly horizontal ridge, the *inferior turbinate crest,* for articulation with the inferior turbinate bone; above the crest, and extending on to the base of the nasal process, is a smooth concave surface belonging to the middle meatus of the nose, and below the crest a much larger surface for the inferior meatus. Behind the nasal process is seen the *lachrymal groove,* nearly vertical, but inclined slightly backwards and outwards, about half an inch in length, and leading into the inferior meatus; the margins overhang the groove in front and behind, and the small interval left is closed by the lachrymal and inferior turbinate bones, thus completing the canal of the nasal duct. Behind the lachrymal groove is the large opening into the antrum; behind this the surface is rough for articulation with the palate bone, and traversing the lower part of this roughness is a smooth groove, passing downwards and forwards from the posterior margin, and completing with the palate bone the posterior palatine or palato-maxillary canal.

Fig. 39.

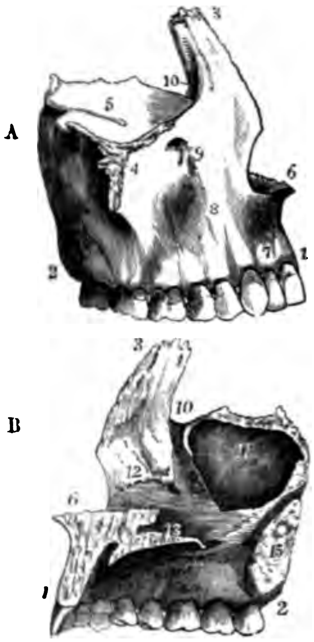

Fig. 39.—SUPERIOR MAXILLARY BONE OF THE RIGHT SIDE. (A. T.) ½

A, from the outside; B, from the inside.

1 to 2, alveolar process—1 at the middle incisor tooth, 2 marks the tuberosity, and above it, in A, the posterior dental foramina; 3, nasal process; 4, malar process; 5, orbital plate, below 5 is the infraorbital groove leading to the canal; 6, placed in front of the nasal notch marks the incisor crest terminating in the anterior nasal spine; 7, incisor fossa; 8, is in front of the canine fossa; 9, infraorbital foramen; 10, lachrymal groove; 11, antrum; 12, inferior turbinate crest; 13, nasal crest; from 13 to 14, the incisor foramen; 15, placed on the surface of articulation of the body with the palate bone, points to the groove of the palato-maxillary canal. These figures also exhibit a full set of the upper teeth of one side as they occur in middle life.

The *orbital surface* is triangular, flat, and smooth; anteriorly it reaches the margin of the orbit for a short distance at the root of the nasal process; externally it is bounded by the rough surface for the malar bone.

The internal border presents, behind the nasal process, an excavation which receives the lachrymal bone, the *lachrymal notch*, and then a straight margin for articulation with the ethmoid and palate bones. The posterior border is smooth, rounded and free, and bounds the spheno-maxillary fissure; the *infraorbital groove* commences here, and leads forwards into the canal of the same name, which opens anteriorly by the infraorbital foramen. From the infraorbital is given off the *anterior dental canal*, which runs down in the substance of the facial portion of the bone, and conveys the anterior dental vessels and nerves.

The *nasal process*, slender and tapering, has an external surface, smooth and continuous with the facial surface of the body, and an internal surface, irregular, fitting against the anterior extremity of the lateral mass of the ethmoid, and completing the foremost cells of that bone. The anterior border is rough, often grooved, for articulation with the nasal bone, and its summit is serrated for articulation with the frontal. Posteriorly it presents a continuation of the *lachrymal groove* already seen on the nasal surface of the body, and which here lodges the lachrymal sac; the groove is bounded internally by a sharp linear edge, which articulates with the lachrymal bone, and externally by a smooth border which forms part of the orbital margin.

The *alveolar border* or *process*, thick and arched, is hollowed out into sockets or *alveoli*, corresponding in number, form, and depth to the roots of the teeth, which are fixed in them.

The *malar process* is thick and triangular; the anterior and posterior surfaces are continuous with the facial and zygomatic surfaces of the body; the superior is rough and grooved to support the malar bone. The inferior border runs down on the outer surface of the body in the form of a thick buttress opposite the first molar tooth.

The *palate process* or *plate*, along with that of the opposite side, forms about three-fourths of the hard palate. Its superior surface is smooth, and concave from side to side; its inferior surface is vaulted and rough, and is marked laterally with groves for nerves and vessels, which reach the palate through the posterior palatine canal. Its posterior extremity falls short of that of the alveolar arch and body of the bone, and articulates with the horizontal plate of the palate bone, which completes the hard palate. The mesial border rises into a serrated vertical ridge, which, with its fellow, constitutes the *nasal crest*—a grooved elevation which receives the lower margin of the vomer; at the fore part this border rises suddenly to a considerable height, and the more elevated portion may be distinguished as the *incisor crest* (Henle); forwards this is prolonged into the anterior nasal spine, on its upper border rests the septal cartilage of the nose, and into the angle behind it the truncated anterior extremity of the vomer fits. Close by the side of the incisor crest on the upper surface of the palate plate is seen a foramen which is directed downwards to the mouth, but in the lower half becomes converted into a wider groove by deficiency of the inner wall. Thus, when the two bones are placed in apposition, one orifice of considerable size is formed on the palatal aspect which divides above into right and left branches leading to the corresponding nasal fossæ; the lower aperture is the *anterior palatine canal*, the lateral branches are the *incisor foramina* (or *canals*), or *foramina of Stenson*. Farther, in the middle line are two other smaller foramina also opening into the anterior palatine canal, one before, the other behind, these are the *foramina of Scarpa*.

The terms *incisor foramen* and *anterior palatine canal* are often used convertibly and vaguely to express what has been above defined as the anterior palatine canal, or its inferior opening. According to the definitions here given, *incisor foramen* has the same meaning in human as in comparative anatomy, while anterior palatine canal is restricted to an appearance which presents itself only in man and a few animals. The lamina which bounds the incisor foramen on the inner side corresponds to the mesial palatine process of the premaxillary bone in other animals, *e.g.* the carnivora; while the incisor foramina are those which are seen largely developed in those animals, and are the remains of a primitive communication between the nose and mouth. The foramina of Scarpa lie in the suture between the laminæ referred to. They transmit the naso-palatine nerves; the nerve of the right side occupying, according to Scarpa, the posterior one, which is usually the larger, and that of the left side, the anterior; but they are very inconstant. (Scarpa, Annot. Anatom., lib. ii. cap. 5.)

Fig. 40.

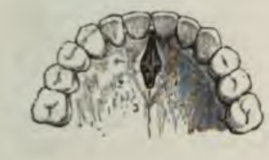

Fig. 40.—FRONT PART OF THE PALATE AND ALVEOLAR ARCH OF AN ADULT. $\frac{2}{3}$

Showing the lower opening of the anterior palatine canal. 1, 2, are placed on the palate plates of the superior maxillary bones; 4, anterior palatine canal, in which is seen a division into four openings—the two lateral, with lines pointing to them from 1 and 2, are the incisor foramina; the anterior and posterior, indicated by 3 and 4, are the foramina of Scarpa.

The *maxillary sinus* or *antrum of Highmore* has an irregularly pyramidal form. The walls are thin, the sides correspond to the facial, zygomatic and orbital surfaces of the body, the base to the nasal surface, and the apex extends into the malar process. The large aperture is closed to a considerable extent by the uncinate process of the ethmoid, the palate and inferior turbinate bones, and in the fresh state is reduced by the mucous membrane to a small orifice through which it communicates with the middle meatus of the nose. Its extent inferiorly generally corresponds with that of the molar teeth, and the outer alveoli of one or more of these form prominences in its floor.

### THE PALATE BONE.

The **palate bone** forms the back part of the hard palate and the lateral wall of the nose between the superior maxillary bone and the internal pterygoid plate. It consists of a *horizontal* and a *vertical plate* united at a right angle, and of three processes, viz., the *pyramidal process*, extending outwards and backwards from the junction of the horizontal and vertical plates, and the *orbital* and *sphenoidal processes*, surmounting the vertical plate.

The palate bone articulates with its fellow, and with the superior maxillary, ethmoid, sphenoid, vomer, and the inferior turbinate bone.

The *horizontal* or *palate plate* presents a superior surface, concave and smooth, forming the back part of the floor of the nasal fossa; and an inferior surface, completing the vault of the hard palate and marked near its posterior border by a transverse ridge to which some tendinous fibres of the tensor palati muscle are attached. The anterior border articulates with the palate process of the superior maxilla; the posterior is free, concave and sharp, giving attachment to the soft palate, and produced at its inner end into a sharp point, which with that of the other side forms the *posterior nasal* or *palatine spine;* internally it articulates with its fellow by a thick serrated border, forming a continuation of the *nasal crest* of the superior maxilla, and also supporting the vomer; externally, at its junction with the vertical plate it is grooved by the extremity of the posterior palatine canal.

The *vertical plate* is very thin. Its internal or nasal surface is divided into two parts, corresponding to the middle and inferior meatuses of the nose, by a nearly horizontal ridge, *inferior turbinate crest,* which articulates with the inferior turbinate bone, and at the upper end of the surface, crossing the roots of the two processes, is another less marked ridge, the *superior turbinate* or *ethmoidal crest,* which articulates with the middle turbinate bone. The external surface presents, nearer to the posterior border, a narrow smooth surface which forms the inner wall of the pterygo-maxillary fissure, and leads down to a deep groove forming with the superior maxillary bone the *posterior palatine canal* for the transmission of the large palatine nerve and vessels; in front of the groove the surface is applied against the superior maxillary bone, and overlaps the orifice of the antrum by a thin tongue-shaped projection, the *maxillary process,* which may attain a considerable size; behind the groove it articulates inferiorly with the hinder border of the maxilla, superiorly with the inner surface of the pterygoid process.

Fig. 41.

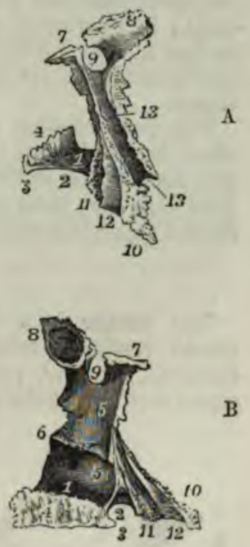

Fig. 41.—THE PALATE BONE OF THE RIGHT SIDE. (A. T.) $\frac{2}{3}$

A, from the outside and behind ; B, from the inside.

1, upper surface of the palate plate ; 2, its posterior curved border ; 3, posterior nasal spine ; 4, the rough surface of adjacent articulation rising superiorly into the nasal crest ; 5, 5, in B, vertical plate ; 6, inferior turbinate crest ; 7, sphenoidal process ; 8, in B, orbital process, showing a cellular cavity ; 8′, in A, its orbital surface ; 9, spheno-palatine notch ; 10, 11, 12, pyramidal process—10, rough surface of union with the external pterygoid plate, 11, with the internal plate, and 12, the intermediate smooth surface ; 13, 13, groove of the posterior palatine canal.

The *pyramidal process* or *tuberosity* fits into the cleft between the pterygoid plates. It presents posteriorly a triangular surface which is smooth and grooved, and completes the pterygoid fossa ; on its sides it is rough for articulation with the borders of the pterygoid plates. Inferiorly, close to its connection with the horizontal plate, are the orifices of the *posterior* and *external small palatine canals* which transmit the smaller palatine nerves ; the external is the smaller and less constant.

The *orbital process* surmounts the anterior margin of the vertical plate. It is somewhat pyramidal in shape, and has five surfaces, two of which, the superior and external, are free, and the rest articulated. The superior surface forms the posterior angle of the floor of the orbit, the external looks into the spheno-maxillary fossa, the anterior articulates with the maxillary, the internal with the ethmoid, and the posterior, which is small and only exists towards the extremity of the process,

### THE NASAL BONE.

The **nasal bones** form the bridge of the nose. They are thick and narrow above, but gradually become wider and thinner below. The superior border of each is serrated, and articulates with the frontal bone; the inferior supports the lateral nasal cartilage; the external border, the longest, articulates with the ascending process of the superior maxillary bone; and the internal with its fellow, with the nasal spine of the frontal bone and with the perpendicular plate of the ethmoid. The anterior surface, concave from above down at its upper part, convex in the rest of its extent, presents a minute vascular foramen; the posterior or nasal surface is marked by a groove for the passage of the nasal nerve.

Fig. 44.

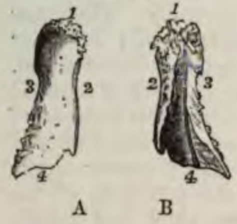

Fig. 44.—Right nasal bone. (A. T.) $\frac{2}{3}$

A, from the front; B, from behind.

1, upper or frontal border; 2, internal border; 3, external or maxillary border; 4, lower free border; in B, 4 is placed at the lower end of the groove for the nasal nerve.

### THE LACHRYMAL BONE.

The **lachrymal bone**, or *os unguis*, is a thin scale of bone placed at the anterior and inner part of the orbit. It articulates superiorly with the frontal bone, posteriorly with the orbital plate of the ethmoid, and anteriorly with the nasal process of the superior maxilla.

The external surface is divided by a vertical ridge, the *lachrymal crest*, into two parts: the anterior is grooved, *lachrymal groove*, for the lachrymal sac, and this part is prolonged inferiorly beyond the orbit in the form of a pointed process which completes the canal of the nasal duct on the inner side and articulates with the inferior turbinate bone; the posterior part, broader, is flat, continuous with the orbital surface of the ethmoid, and is produced below into a hook-like projection, *hamular process*, which curves forwards in the lachrymal notch of the superior maxilla and bounds the orifice of the nasal duct on the outer side. The internal surface superiorly completes some anterior ethmoidal cells, and inferiorly looks into the middle meatus of the nose.

Fig. 45.

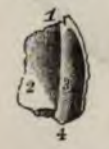

Fig. 45.—Right lachrymal bone, from the outside. (A. T.) $\frac{2}{3}$

1, upper or frontal border; 2, orbital surface; 3, lachrymal groove; 4, the process which meets the inferior turbinate bone.

### THE INFERIOR TURBINATE BONE.

The **inferior turbinate** or **spongy bone**, *maxilloturbinal*, is a slender lamina, attached by the upper margin along the lateral wall of the nose, and projecting into the nasal cavity, so as to divide the middle from the inferior meatus. It is slightly convoluted, its convexity looking inwards, and its lower margin is free, slightly thickened and pon itself. The attached margin articulates anteriorly with the inferior turbinate crest of the superior maxillary bone, then ascends abruptly to form the *lachrymal process* and complete the lachrymal canal and articulate with the lachrymal bone; behind this it is folded downwards in the *maxillary process*, forming part of the inner wall of the antrum below the entrance into that cavity; above and behind this, it presents a small projection which articulates with the uncinate process of the ethmoid, *ethmoidal process*, and posteriorly it is attached to the inferior turbinate crest of the palate bone. The posterior extremity is elongated, sharp and pointed; the anterior flattened and obtuse.

Fig. 46.

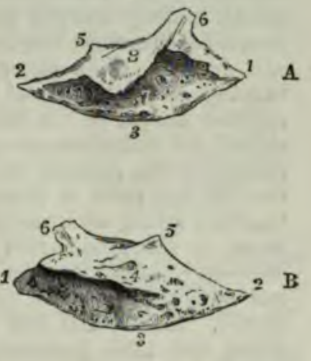

Fig. 46.—THE INFERIOR TURBINATE BONE OF THE RIGHT SIDE. (A. T.) $\frac{2}{3}$

A, from the outside; B, from the inside.

1, anterior angle; 2, posterior angle; 1, 3, 2, inferior free border; 4, internal convex surface; 5, ethmoidal process; 6, lachrymal process; 7, outer concave surface; 8, maxillary process.

This bone is marked by horizontal grooves and canals for vessels and nerves, but not, as the turbinal parts of the ethmoid are, with vertical grooves for the olfactory nerve.

### THE INFERIOR MAXILLARY BONE.

The **lower jaw,** *inferior maxilla, mandible,* is the thickest and strongest bone of the face, and moves on the rest of the skull by means of a pair of condyles articulating with the glenoid fossæ of the temporal bones. It has the shape of an inverted arch bent forwards upon itself, and consists of a middle larger horizontal part—the *body*, and of two *rami* or ascending branches.

Fig. 47.

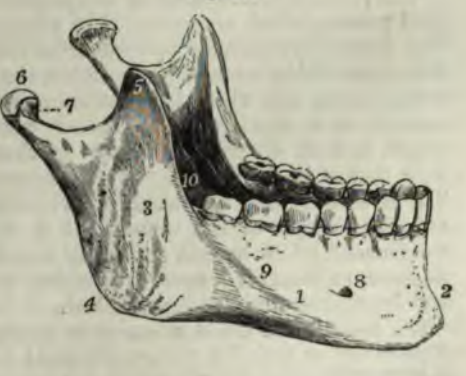

Fig. 47.—THE INFERIOR MAXILLARY BONE, FROM THE RIGHT SIDE AND ABOVE. (A. T.) $\frac{1}{2}$

1, body; 2, symphysis; 3, ramus; 4, angle, near it the oblique ridges marked by the attachment of the masseter muscle; 5, coronoid process; 6, condyle; 7, placed in the sigmoid notch, points to the front of the neck; 8, mental foramen; 9, external oblique line; 10, inferior dental foramen and mylohyoid groove of the left side. This figure represents a full set of the teeth of the lower jaw in middle life. (See also fig. 54 for view of the inner surface of the lower jaw.)

The *body* is marked in the middle line by a vertical ridge, indicating the place of union of the originally separate lateral parts, and thence named the *symphysis;* this is continued below into the triangular elevation, *mental prominence*, forming the chin, a feature peculiar to the human skull. The superior or *alveolar* border is hollowed out into sockets for the teeth. The inferior border or *base* is thick and rounded, and projects beyond the superior. On the outer surface, on each side of the symphysis, below the incisor teeth, is a shallow depression, the *incisor fossa*, and more externally is the *mental foramen*, placed midway between the upper and lower borders and under the interval between the two bicuspid teeth; it transmits the mental nerve and vessels. Close below the foramen is the *external oblique line*, running from the mental prominence upwards and backwards to the anterior margin of the ramus. The deep surface is marked, on each side of the symphysis, along the inferior margin, by an oval depression, indicating the anterior attachment of the digastric muscle, and above this by two pairs of prominent tubercles, *mental spines*, placed close together, giving attachment, the upper pair to the genio-glossi, and the lower to the genio-hyoid muscles. An oblique prominent line, the *mylo-hyoid ridge*, leading from beneath the mental spines, upwards and backwards to the ramus, gives attachment to the mylo-hyoid muscle. Above this line is a smooth depression for the sublingual gland, and more posteriorly beneath it another for the submaxillary gland.

The *ramus* is thinner than the body of the bone. Its posterior border in meeting the line of the base forms the *angle* of the jaw. The external surface is flat and uneven, and towards the angle stronger ridges mark the attachment of tendinous bundles of the masseter muscle. The internal surface presents at its middle the *inferior dental foramen*, leading into the *dental canal*, which lodges the dental nerve and vessels. Passing down from the sharp internal margin of this foramen is the *mylo-hyoid groove* (occasionally a canal for a short space) marking the passage of the mylo-hyoid nerve with an accompanying artery and vein. Behind this, inside the angle, is a marked roughness for the internal pterygoid muscle.

The ramus is surmounted by two projections, the condyle and the coronoid process, which are separated by a deep excavation, the *sigmoid notch*. The *condyle* is continued upwards from the posterior part of the ramus. It is supported by a constricted portion, the *neck*, which presents anteriorly a depression, into which the external pterygoid muscle is inserted. The condyle is a transversely elongated convex articular process, whose major axis is directed obliquely, so that if prolonged it would meet with that of its fellow near the anterior margin of the foramen magnum. The *coronoid process* is continued vertically upwards in front, from the anterior margin of the ramus. It is triangular in shape, and gives attachment by its margin and inner aspect to the temporal muscle. At its base, in front, is a groove, in which the lower parts of the temporal and buccinator muscles are attached.

The angle of the jaw is in the adult usually about 120°; in infancy it is as great as 140° or more; in strongly developed jaws it may be diminished to 110° or less; and in old and toothless jaws it is increased. These changes are connected with a variety of circumstances, among which may be noticed,—the development of the temporary and permanent teeth, the absorption of the alveolar arch after the loss of the teeth in advanced age, the elongation of the face and upper jaw towards adult life, and the varying state of development of the masseter muscles at different periods.

### THE HYOID BONE.

The **hyoid bone**, or *os linguæ*, is situated at the base of the tongue, and may be felt between the chin and the thyroid cartilage. It is shaped like the letter U, and consists of a body and two pairs of cornua. It is suspended from the tips of the styloid processes of the temporal bones by a pair of slender bands, the *stylo-hyoid ligaments*, which in most animals form distinct bones. Though belonging rather to the neck than to the cranium or face, it may be suitably considered in this place.

Fig. 48.

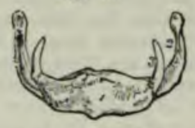

Fig. 48.—THE HYOID BONE, FROM BEFORE. $\frac{2}{3}$

1, the prominent part of the body; 2, the great cornu; 3, the small cornu.

The *body*, or central piece, *basihyal*, is compressed from before backwards, and lies in a plane directed downwards and forwards. Its anterior surface is convex, and marked in the middle by a vertical ridge, on each side of which are depressions for the attachment of muscles. Its posterior surface is concave, and is directed towards the epiglottis.

The *great cornua, thyrohyals*, project backwards from the sides of the body; they are compressed from above down and end in rounded extremities.

The *small cornua*, or *cornicula, ceratohyals*, short and conical, project upwards and backwards from the place of junction of the body with the great cornua, and give attachment at their extremities to the stylo-hyoid ligaments. They are commonly in part, and not unfrequently entirely, cartilaginous.

The great cornua are connected to the body by synchondrosis, and after middle life by bony union; the small cornua by a synovial articulation which is seldom anchylosed.

## THE SKULL AS A WHOLE.

### THE SUTURES.

With the exception of the lower jaw, which is moveably articulated with the temporal bone, the bones of the skull are closely fitted together by more or less uneven edges or surfaces, there being interposed only a small quantity of fibrous tissue, continuous with the periosteum; and to the lines of articulation the name *suture* is given. At the base of the cranium, however, in young subjects, the basilar process of the occipital is connected to the sphenoid, and the jugular process to the petrous, by a thin layer of cartilage; the articulation is therefore synchondrosis, and when adult age is reached it becomes converted into bony union.

The sutures are best named from the bones between which they lie, as, occipito-parietal, occipito-mastoid, fronto-ethmoidal, &c. Those around the parietal bones are the longest and most regular, and to these special names have been applied; thus, above, between the two parietal bones is the *sagittal* or *interparietal suture;* posteriorly is the deeply serrated *lambdoid* or *occipito-parietal suture;* anteriorly is the *coronal* or *fronto-parietal suture*, most markedly serrated in the middle part of each lateral half, less so above where the frontal bone overlaps the parietal, and quite simple at the lower end where the parietal overlaps the frontal; inferiorly is the *temporo-parietal suture* consisting of two parts, the *squamous suture* arched in form, in which the squamous part of the temporal overlaps the parietal, and the *parieto-mastoid*, short and serrated; while at the antero-inferior angle is the short *spheno-parietal suture*, about half an inch in length, absent only in rare cases when the frontal and temporal bones come into contact.

The cranial sutures are conveniently arranged by Turner in three groups, a *median longitudinal*, a *lateral longitudinal* and a *vertical transverse*. The first consists of the sagittal suture, which is continued in the infant, and frequently in the adult, by the frontal suture; in the lateral longitudinal are included on each side, the fronto-nasal, fronto-maxillary, fronto-lachrymal, fronto-ethmoidal, fronto-malar, fronto-sphenoidal, spheno-parietal, squamous, and parieto-mastoid sutures; the third comprises the coronal and spheno-squamous, the lambdoid and occipito-mastoid sutures, and into this group also would fall the transverse articulations in the centre of the base, between the ethmoid, sphenoid and occipital.

After adult life is reached the bones of the skull evince a disposition to unite and many of the sutures thereby become closed, but the period at which this commences, as also the order in which it proceeds, are subject to great variations and afford very little assistance in determining the precise age of a skull. The process commences generally between thirty and forty years of age; the union takes place first on the inner surface, and frequently the large sutures are quite obliterated internally whilst they are perfectly distinct on the external surface. The earliest points to close are commonly the part of the sagittal suture between the parietal foramina, and the lower ends of the coronal suture; the more dentated parts of these sutures and the lambdoid follow later. The squamous is very late in closing, and it is noteworthy that when the frontal suture fails to unite at the usual time it may remain unchanged even to very advanced age.

**Wormian bones.** *Ossa triquetra*, *ossa suturarum*. These are irregular ossifications, found in many skulls, interposed between the cranial bones; seldom in the face. They are of irregular form, with margins adapted to the character of the sutures in which they are situated; usually of small size, but may exceed an inch in diameter. Their most frequent seat is in the occipito-parietal suture, where they sometimes occur in great numbers, more or less symmetrically arranged: in some cases one or several bones of considerable size occupy the place of the superior part of the occipital, more rarely of the antero-superior angles of the parietal bones: a scale-like ossification is often seen between the antero-inferior angle of the parietal and the great wing of the sphenoid (*epipteric bone*, Flower). They are much less frequent in the other sutures.

### EXTERNAL SURFACE OF THE SKULL.

The external surface of the skull may be conveniently divided into superior, inferior, anterior, and lateral regions.

The **superior region,** extending from the supraorbital ridges in front to the superior curved line of the occipital bone behind, and bounded laterally by the temporal lines, is smooth and convex, covered only by the integument and by the muscular fibres and aponeurosis of the occipito-frontalis muscle. It is of an oval form, broader in the parietal than the frontal region, flattened in front, and projecting somewhat in the middle behind. There is also a slight projection from the general curve at each of the frontal and parietal eminences.

The **anterior region** of the skull, below the forehead, presents the openings of the orbits, bounded by the frontal, malar, and superior maxillary bones; and between the orbits, the bridge of the nose, formed by the nasal bones and ascending processes of the superior maxillaries.

Below the nasal bones is the *anterior nasal aperture,* of an inverted heart shape: its thin margin gives attachment to the nasal cartilages, and projects forwards in the middle line below as the anterior nasal spine. Below the nasal aperture are the incisor fossæ of the upper jaw; below the orbits are the canine fossæ; and external to the canine fossæ are the prominences of the cheeks, formed by the anterior inferior parts of the malar bones. The lower jaw completes the skeleton of the face. The foramina in this region, on each side, are the supraorbital foramen or notch in the superior margin of the orbit, the infraorbital foramen below the inferior margin of the orbit, the mental foramen of the lower jaw, and the small malar canal of the malar bone.

Fig. 49.

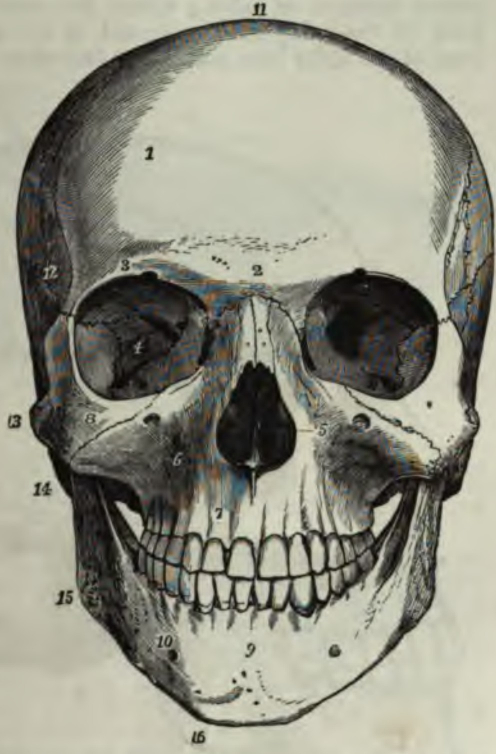

Fig. 49.—FRONT VIEW OF MALE SKULL AT ABOUT TWENTY YEARS. (A. T.) ½

1, frontal eminence; 2, glabella, between the superciliary ridges, and above the transverse suture of union with the nasal and superior maxillary bones; 3, orbital arch near the supraorbital notch; 4, orbital surface of the great wing of the sphenoid, between the sphenoidal and the spheno-maxillary fissures; 5, anterior nasal aperture, within which are seen in shadow the vomer and the turbinate bones; 6, superior maxillary bone at the canine fossa—above the figure is the infraorbital foramen; 7, incisor fossa; 8, malar bone; 9, symphysis of lower jaw; 10, mental foramen; 11, vertex, near the coronal suture; 12, temporal fossa; 13, zygoma; 14, mastoid process; 15, angle of the jaw; 16, mental prominence. In this skull there are fourteen teeth in each jaw, the wisdom teeth not having yet appeared.

The **orbits** are pyramidal fossæ, irregularly quadrilateral, with their bases directed forwards and slightly outwards, their inner walls being nearly parallel, and their outer walls diverging so as to be nearly at right angles to each other. The roof of each orbit is formed by the orbital plate of the frontal and the small wing of the sphenoid; the floor by the malar and superior maxillary bones, and by the small orbital surface of the palate bone at the back part; the inner wall by the nasal process of the superior maxilla, the lachrymal, the ethmoid and body of the sphenoid; and the outer wall by the orbital surfaces of the malar bone and great wing of the sphenoid. The *sphenoidal fissure* (foramen lacerum orbitale) at its inner extremity occupies the apex of the orbit, while its outer and narrower part lies between the roof and the external wall. The optic foramen is internal and superior to the sphenoidal fissure. In the angle between the external wall and the floor is the *spheno-maxillary fissure*, bounded by the sphenoid, palate, superior maxillary, and malar bones, and leading into the spheno-maxillary fossa at its back part, and the zygomatic fossa at its fore part. Passing forwards from the margin of the spheno-maxillary fissure is the commencement of the infraorbital canal, grooving the posterior part of the floor of the orbit. On the inner wall in front is the *lachrymal groove*, formed by the superior maxillary and lachrymal bones, and leading into the nasal duct; farther back, between the ethmoid and frontal bones, are the *anterior* and *posterior internal orbital canals:* on the roof at its anterior margin, is the supra-orbital foramen or notch; within the external angular process is the fossa for the lachrymal gland; and in the outer wall are the temporal canal of the malar bone and one or two other minute foramina.

Fig. 50.

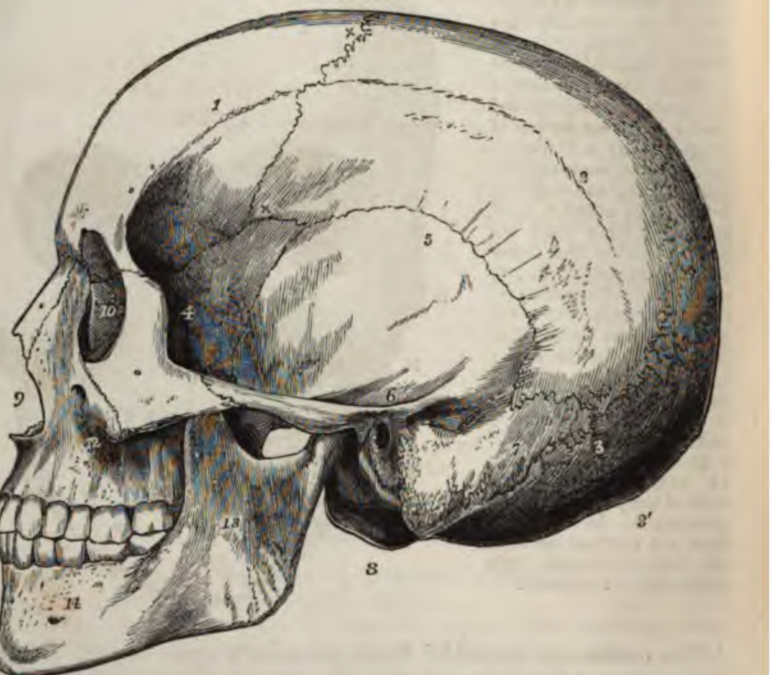

Fig. 50.—Lateral view of the skull represented in figure 49. (A. T.) ½

1, frontal bone; 2, parietal bone at the upper temporal line; × ×, coronal suture; 3, on the occipital bone at the lower end of the lambdoid suture, near its meeting with the occipito-mastoid and parieto-mastoid sutures; 3′, external occipital protuberance; 4, great wing of sphenoid; 5, squamous part of temporal; 6, the same at the root of the zygoma, immediately over the external auditory meatus; 7, mastoid portion of temporal, in front of which is the mastoid process; 8, left condyle of the occipital bone; 9, anterior nasal aperture; 10, on the lachrymal bone in the inner wall of the orbit; 11, malar bone, near its junction with the zygoma; 12, superior maxillary bone behind the canine fossa; 13, ramus of the lower jaw; 14, body of the lower jaw, near the mental foramen.

The **lateral region** of the skull presents in succession from behind forwards the mastoid process, the external auditory meatus, the glenoid fossa, with the condyle of the lower jaw, the *zygomatic arch*, formed by the zygomatic process of the temporal bone and the posterior part of the malar, and internal to this the coronoid process of the lower jaw.

Above the zygomatic arch is the temporal fossa, below is the zygomatic fossa, the two being separated by the infratemporal crest on the great wing of the sphenoid. The *temporal fossa* is occupied by the temporal muscle, and the squamous part of the temporal, the parietal, frontal, sphenoid and malar bones take part in its formation.

Fig. 51.

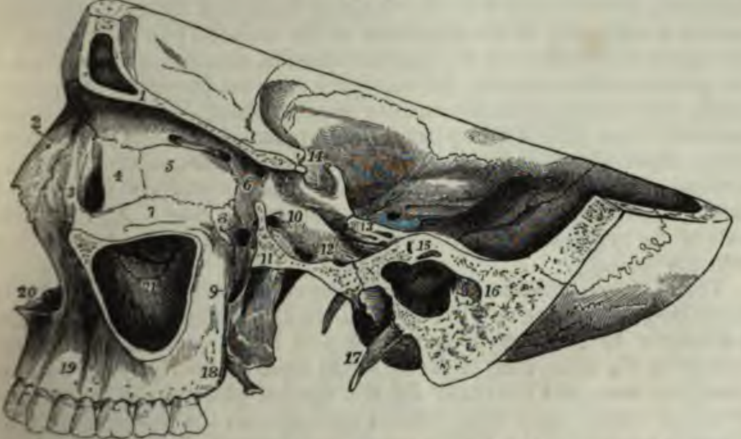

Fig. 51.—SECTION OF MALE SKULL OF MIDDLE AGE, IN TWO PLANES, ONE PASSING VERTICALLY THROUGH THE LEFT ORBIT, THE OTHER OBLIQUELY FROM BEHIND THE ORBIT, BACKWARDS AND OUTWARDS, THROUGH THE TYMPANUM AND MASTOID PROCESS. (A. T.) $\frac{1}{2}$

1, section of the frontal bone in the roof of the orbit ; 2, left nasal bone ; 3, nasal process of the superior maxillary bone ; 4, left lachrymal bone, and in front the lachrymal groove ; 5, placed on the orbital plate of the ethmoid, below the anterior internal orbital canal ; 6, placed on the body of the sphenoid, between the optic foramen and the posterior internal orbital canal, and in front of the sphenoidal fissure ; 7, orbital plate of the superior maxillary bone inside the infraorbital groove ; 8, on the orbital plate of the palate bone, in front of and above the spheno-palatine foramen and spheno-maxillary fossa ; 9, upper extremity of the posterior palatine canal ; 10, cranial opening of the foramen rotundum—its anterior opening is seen in the spheno-maxillary fossa ; 11, section of the great wing of the sphenoid bone outside the foramen ovale, and in the fossa near it the anterior opening of the Vidian canal ; 12, placed between the spinous and oval foramina ; 13, on the anterior surface of the petrous bone, near the apex. In front of the figure is seen the sigmoid groove of the internal carotid artery, and below the figure and externally the hiatus Fallopii ; 14, the pituitary fossa, with the anterior and posterior clinoid processes ; 15, section of the petrous bone above the labyrinth ; two of the semicircular canals are opened ; immediately below is the tympanum. The inner wall is seen with the promontory, fenestra ovalis and pyramid in shadow ; forwards near ×, the tympanic opening of the Eustachian tube, and backwards, below 16, the opening into the mastoid cells ; 17, left styloid process—that of the right side is seen in perspective below the skull, close by the occipital condyle ; 18, tuberosity of the superior maxilla ; 19, below the canine fossa ; 20, nasal notch and anterior nasal spine ; 21, inner wall of the antrum seen by the removal of its outer wall ; above the figure is the maxillary process of the inferior turbinate bone, and over that an irregular fissure, viz., the opening of the antrum into the middle meatus of the nose.

The temporal fossa is bounded above by the temporal crest of the frontal bone and the temporal line of the parietal. It has been pointed out by Hyrtl that the latter line is double, and the two lines can usually be traced readily enough on the side of the skull. The inferior line turns down posteriorly to become continuous with the posterior root of the zygoma on the temporal bone, it marks the limit of the temporal muscle, and is the boundary of the temporal fossa; the upper line, a variable distance above this, gives attachment to the temporal fascia, and is the line of division between the upper and lateral surfaces of the skull.

The *zygomatic fossa* is an irregular hollow in part covered by the ramus of the lower jaw; its wall is formed internally by the external pterygoid plate; superiorly by the lower part of the great wing of the sphenoid, in which are seen the foramen ovale and foramen spinosum, and by a small part of the squamous of the temporal; and anteriorly by the zygomatic surface of the superior maxilla, presenting the orifices of the posterior dental canals. Inferiorly the external pterygoid plate comes nearly into contact with the superior maxillary bone, but is almost always separated from it by a thin portion of the pyramidal process of the palate bone; superiorly, it is divided from it by the *pterygo-maxillary fissure*, a vertical slit which leads above into the spheno-maxillary fossa, but is closed internally by the vertical plate of the palate bone. At the upper part of the zygomatic fossa the horizontal spheno-maxillary fissure leads into the orbit.

The *spheno-maxillary fossa* is the space which lies in the angle between the pterygo-maxillary and the spheno-maxillary fissures. It is bounded posteriorly by the pterygoid process and lower part of the anterior surface of the great wing of the sphenoid bone, anteriorly by the superior maxillary bone, and internally by the vertical plate of the palate bone. Into this narrow space five foramina open, *viz.*, on the posterior wall, the foramen rotundum, the Vidian canal, and, between the sphenoidal process of the palate bone and the root of the internal pterygoid plate, the pterygo-palatine canal; on the inner wall, the spheno-palatine foramen formed by the palate bone and the sphenoid, and opening into the nasal cavity; and inferiorly, the posterior palatine canal, which leads down to the palate between the palate and superior maxillary bones.

The **external base of the skull,** excluding the lower jaw, is divisible into three parts, anterior, middle, and posterior.

The *anterior division* consists of the palate and the alveolar arch. It is traversed longitudinally by a mesial suture, and transversely by that between the maxillary and palate bones. Anteriorly, in the middle line, is the anterior palatine canal, with the four smaller foramina contained within it; posteriorly, on each side, at the base of the alveolar arch, is the posterior palatine canal, and externally and posteriorly to that, the posterior and external small palatine canals. The palate is surrounded in front and on the sides by the alveolar arch bearing the teeth of the upper jaw.

The *middle division* extends back to the front of the foramen magnum. Its central portion has been called the *guttural fossa*. In the middle line is the basilar process of the occipital bone, and in front of that the body of the sphenoid, covered anteriorly by the extremity of the vomer. On each side, the petrous portion of the temporal bone reaches as far forwards as the extremity of the basilar process; and between the petrous and squamous portions is the back part of the great wing of the sphenoid bone. Between this division of the base of the skull and the palate are the *posterior nares*, separated by the vomer, and bounded above by the body of the sphenoid bone, below by the horizontal plates of the palate bones, and laterally by the internal pterygoid plates. On each side of the posterior nares is the pterygoid fossa, and a line from the external pterygoid plate to the spine of the sphenoid forms the division between this region and the zygomatic fossa. Immediately behind or internal to this line is the groove for the cartilaginous part of the Eustachian tube, formed by the margins of the great wing of the sphenoid and the petrous, and leading to the osseous part of the tube in the temporal bone. Between the apex of the petrous, the basilar process and the sphenoid is the foramen lacerum: in a line proceeding backwards and outwards from this are the free surface of the petrous, the lower orifice of the carotid canal, the vaginal and styloid processes, and

Fig. 52.

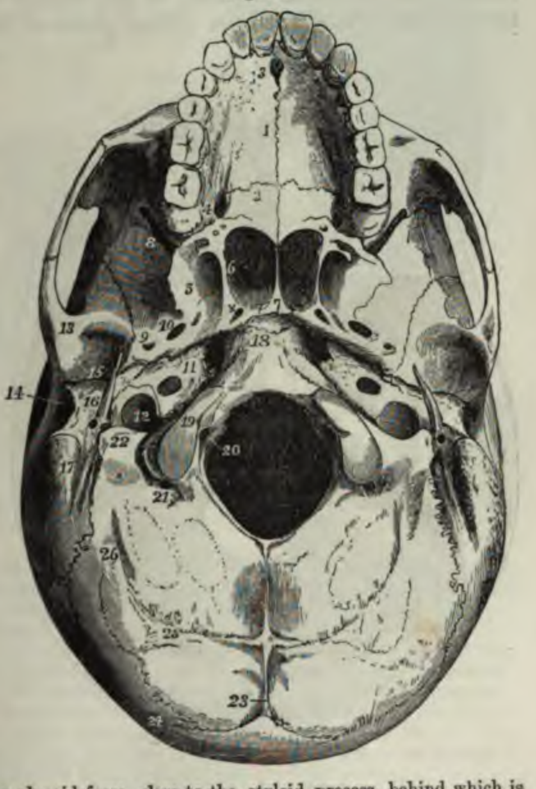

Fig. 52.—External base of the skull shown in figure 49. (A. T.) ½

1, palate plate of the superior maxillary bone; 2, palate plate of the palate bone; 3, anterior palatine canal; 4, is placed outside the posterior palatine canal, inside the tuberosity of the superior maxilla, and in front of the smaller posterior palatine canals; 5, inner surface of the external pterygoid plate; 6, is placed within the posterior opening of the right nasal fossa on the internal pterygoid plate; 7, vomer; ×, posterior opening of the pterygo-palatine canal in front of the foramen lacerum; 8, spheno-maxillary fissure leading into the orbit; 9, foramen spinosum; 10, foramen ovale; 11, placed on the apex of the petrous bone, between the foramen lacerum and the inferior opening of the carotid canal; 12, jugular foramen; 13, articular eminence of the temporal bone; 14, external auditory meatus; 15, glenoid fossa in front of the fissure of Glaser; 16, tympanic plate or posterior part of the glenoid fossa, close to the styloid process, behind which is seen the stylo-mastoid foramen; 17, mastoid process, and to its inside the digastric and occipital grooves; 18, basilar process of the occipital bone, and in front the mark of the still incomplete union with the body of the sphenoid bone; 19, condyle of the occipital bone; 20, is placed in the foramen magnum, and points to the inner opening of the anterior condylar foramen; 21, posterior condylar foramen; 22, jugular process of the occipital bone; 23, external occipital crest running down from the protuberance; 24, superior curved line of the occipital bone; 25, 26, inferior curved line.

the stylo-mastoid foramen ; whilst internal to these are the jugular and anterior condylar foramina.

The *posterior division* presents on each side of the foramen magnum, from within outwards, the occipital condyle, the rough surface for the rectus capitis lateralis muscle, the occipital groove of the temporal bone, the digastric fossa, and the mastoid process. Behind the foramen magnum is the tabular part of the occipital bone, with its ridges and muscular impressions.

### THE INTERIOR OF THE CRANIUM.

The walls of the cranium consist of two layers of compact bony substance, the *outer* and *inner tables*, and an intervening cancellated substance, called *diploe*. The inner or *vitreous* table, has a smooth, close-grained, shining appearance, is hard and brittle, and presents irregular digitate impressions corresponding to the convolutions of the brain. The thinnest portions of the cranial wall are the cribriform plate of the ethmoid and the orbital plates of the frontal bone, in both

Fig. 53.

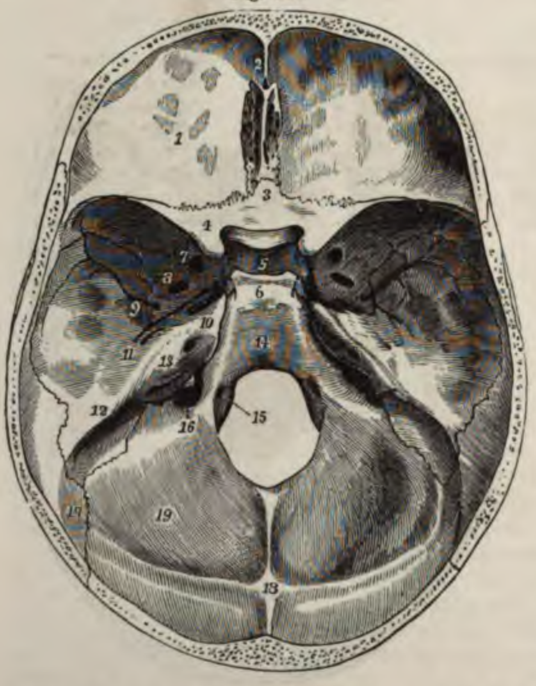

Fig. 53. — INTERNAL BASE OF THE SKULL. (A. T.) $\frac{1}{2}$

1, anterior fossa and roof of the orbit, as formed by the frontal bone ; between 2 and 3, the foramen cæcum, crista galli and cribriform plate of ethmoid ; 3, ethmoidal spine of the sphenoid ; 4, lesser wing of sphenoid terminating posteriorly in the anterior clinoid process, inside which is the optic foramen ; 5, placed in the pituitary fossa, behind the olivary eminence and transverse groove of the optic commissure ; 6, dorsum sellæ, terminating in the posterior clinoid processes ; 7, foramen rotundum, in front of which, but not seen in the figure, is the sphenoidal fissure ; 8, foramen ovale ; 9, foramen spinosum ; 10, on the petrous bone, near its apex, and to the inside of the hollow occupied by the Gasserian ganglion ; in front of this is the foramen lacerum ; 11, in front of the eminence of the superior semicircular canal, and behind the hiatus Fallopii ; 12, upper border of the petrous, marked by the superior petrosal groove ; 13, the posterior surface of the petrous —to the inside, the internal auditory meatus, behind, the scale of bone covering the aqueduct of the vestibule ; 14, basilar groove ; 15, anterior condylar foramen ; 16, jugular foramen ; 17, groove of the lateral sinus ; 18, internal occipital protuberance, and running down from it the internal occipital crest ; between 17 and 18, the upper part of the groove of the lateral sinus, between 17 and 16, the lower part ; 19, cerebellar fossa.

of which the diploe is entirely absent; the bone is also thin and compact in the middle part of the inferior occipital fossæ, and in the squama and glenoid fossa of the temporal.

The upper part of the cranial cavity consists of a single vaulted dome formed by the frontal, parietal, and occipital bones. It is marked by the superior longitudinal groove, by shallow cerebral impressions, by small ramified meningeal grooves, and by Pacchionian fossæ of varying

Fig. 54.

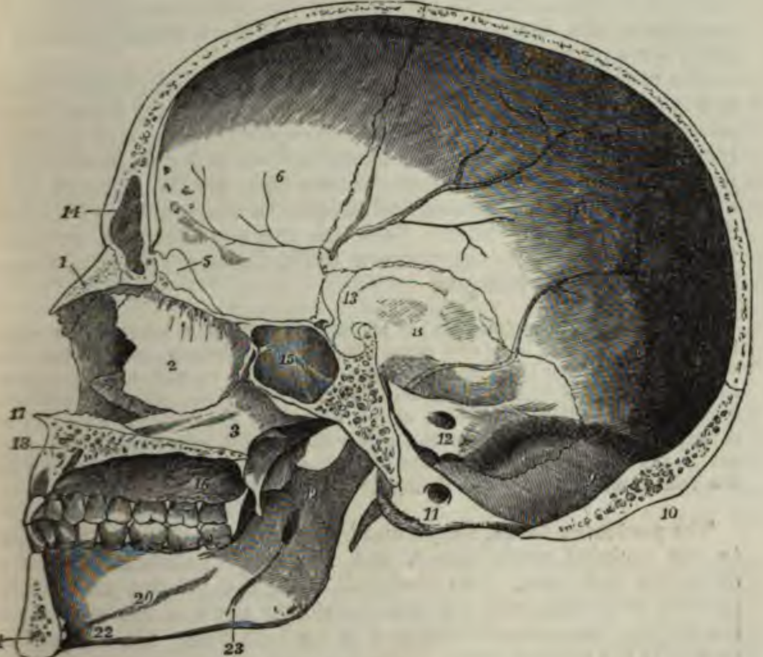

Fig. 54.—Sagittal section of the adult skull a little to the left of the middle line. (A. T.) ½

1, nasal bone; 2, perpendicular plate of the ethmoid with olfactory foramina and grooves at its upper part; 3, vomer; 4, right superior maxillary bone, forming part of the wall of the right nasal fossa; below this, the anterior extremity of the right inferior turbinate bone overhanging ×, which is the right inferior meatus of the nose; 5, crista galli; 6, inner surface of the frontal bone; 7, of the parietal bone; 8, squamous part of the temporal; 9, on the occipital bone below the internal occipital protuberance; 10, external occipital protuberance; 11, on the condylar process below the anterior condylar foramen; 12, on the posterior surface of the petrous below the internal auditory meatus; between 9 and 12, the groove of the right lateral sinus; 13, placed above the sella turcica; 14, left frontal sinus; 15, left sphenoidal sinus, the figure being placed on the sphenoidal septum; 16, hard palate and alveolar arch—the figure is placed near the lower opening of the posterior palatine canal, and the grooves which extend forwards from it; 17, anterior nasal spine; 18, section of the left superior maxillary bone, and near the place to which the line points, the section of the anterior palatine canal; 19, on the inner surface of the ramus of the lower jaw, below the sigmoid notch, and above the inferior dental foramen; 20, inner surface of the body of the jaw on the mylo-hyoid ridge; 21, surface of section of the lower jaw to the left of the symphysis; behind the symphysis, and between 21 and 22, the mental spines; 23, mylo-hyoid groove.

depth. The lower part or *internal base* of the skull is divided into three fossæ, named anterior, middle, and posterior.

The **anterior fossa**, formed by the orbital plates of the frontal bone, the cribriform plate of the ethmoid, and the small wings and part of the body of the sphenoid, supports the frontal lobes of the brain. It is convex laterally over the orbits, but sinks into a hollow over the cribriform plate of the ethmoid, in the middle line of which the crista galli stands up, separating the deep olfactory grooves for the reception of the olfactory bulbs. In front of the crista galli is the foramen cæcum, on each side are the numerous apertures of the cribriform plate, the inner openings of the internal orbital canals and the foramen by which the nasal nerve passes into the nose.

The **middle fossa**, on a lower level than the anterior, presents a mesial and two lateral parts. The mesial part is small, being formed by the olivary eminence and sella turcica of the sphenoid bone, and limited behind by the dorsum sellæ. The lateral part on each side, formed by the great wing of the sphenoid, the squamous part, and the anterior surface of the petrous part of the temporal, lodges the temporal lobe of the brain. The foramina of the middle fossa are the optic foramen, sphenoidal fissure, foramen rotundum, foramen ovale, foramen spinosum, foramen lacerum and hiatus Fallopii.

The *foramen lacerum* (medium) is an irregular aperture between the apex of the petrous and the body and great wing of the sphenoid, and in the recent state is closed below by a mass of fibrous tissue; the carotid canal opens on its external wall, the Vidian canal anteriorly. The lingula projecting backwards from the body of the sphenoid effects a partial, sometimes a complete subdivision of the space; by the inner part the carotid artery enters the cranial cavity, and through the external the large superficial petrosal nerve, coming from the Vidian, reaches the hiatus Fallopii.

The **posterior fossa**, deeper and larger than the others, extends back to the occipital protuberance, and lodges the cerebellum, medulla oblongata and pons. The occipital bone, the petrous and mastoid portions of the temporal, the postero-inferior angle of the parietal and the body of the sphenoid take part in its formation. On the posterior surface of the petrous, which limits this fossa anteriorly on each side, is the internal auditory meatus; lower down is the jugular foramen; between that and the foramen magnum is the anterior condylar foramen.

The *jugular foramen* (foramen lacerum posterius) is formed by the jugular notches of the petrous and occipital bones; somewhat pyriform in shape, two more or less marked constrictions indicate a division into three compartments; most externally and posteriorly is a large rounded part occupied by the lateral sinus; the middle part, corresponding to a distinct notch in the lower border of the petrous, transmits the ninth, tenth, and eleventh nerves, and the most anterior and internal, sometimes completely separated by a spiculum of bone, gives passage to the inferior petrosal sinus.

*Grooves for Bloodvessels.*—The groove of the middle meningeal artery commences at the foramen spinosum, and ramifies principally on the squamous portion of the temporal bone and on the parietal. The groove of the internal carotid artery lies on the side of the body of the sphenoid, and terminates inside the anterior clinoid process. The groove of the superior longitudinal sinus, commencing at the frontal crest, passes backwards in the middle line of the roof of the skull, and terminates at the internal occipital protuberance. From that point the grooves of the lateral sinuses pass outwards on the occipital bone, cross the posterior inferior angles of the parietal bones, descend on the mastoid portions of the temporal bones, run inwards again on the occipital, and turn forwards to terminate at the jugular foramen. The groove of the inferior petrosal sinus lies between the petrous portion of the temporal bone and the basilar process; that of the superior petrosal sinus extends along the superior edge of the petrous portion.

### THE NASAL CAVITIES AND COMMUNICATING AIR SINUSES.

The **nasal cavities**, or **fossæ**, are placed one on each side of a median vertical septum. They open in front by the anterior nasal aperture and behind by the posterior nares already described, and communicate with the sinuses of the frontal, ethmoid, sphenoid, and superior maxillary bones. Their vertical extent, as well as that from before backwards, is considerable, but their transverse width is very limited, especially in the upper part.

The *internal wall*, or *septum nasi*, is formed by the central plate of the ethmoid, the vomer, the nasal spine of the frontal, the rostrum of the sphenoid, and the crests of the maxillary and palate bones. It presents a great angular deficiency in front, which in the recent state is filled up by the septal cartilage. In most cases it deviates somewhat from the middle line to one side or the other.

The *roof* is horizontal in its middle part, but sloped downwards before and behind. The middle part is formed by the cribriform plate of the ethmoid, the fore part by the frontal and nasal bones, and the back part by the body of the sphenoid, the ala of the vomer and the sphenoidal process of the palate bone. It presents the apertures of the cribriform plate and the orifice of the sphenoidal sinus.

The *floor*, formed by the palate plates of the maxillary and palate bones, is smooth, and concave from side to side. Towards its anterior extremity is the orifice of the incisor foramen.

The *external wall* is the most extensive. The bones which take part in its formation are the nasal, superior maxillary, lachrymal, ethmoid, inferior spongy, and palate bones, and the internal pterygoid plates. The superior and inferior turbinate processes of the ethmoid bone, and the inferior spongy bone projecting inwards, overhang the three hollows called *meatuses*. The *superior meatus*, very short, is placed between the superior and inferior turbinate parts of the ethmoid; into it open anteriorly the posterior ethmoidal cells, and posteriorly the spheno-palatine foramen. The *middle meatus*, the space between the inferior turbinate part of the ethmoid and the inferior spongy bone, communicates at its fore part by means of the infundibulum, with the anterior ethmoidal cells and the frontal sinus, while in its middle is the opening of the maxillary sinus. The *inferior meatus*, longer than the others, lies between the inferior spongy bone and the floor of the nasal cavity, and in its fore part is the orifice of the nasal duct.

The **air sinuses** are hollows within the ethmoid, frontal, sphenoid, and maxillary bones, which communicate with the nasal cavities by narrow orifices. With the exception of the maxillary sinus these cavities are absent in early youth. The *maxillary sinus* begins to be formed about the fourth month of fœtal life; the frontal, ethmoidal and sphenoidal first appear during childhood, but remain of small size up to the time of puberty, when they undergo a great enlargement. In advanced life they all increase in size by absorption of the cancellated tissue in their vicinity. The *ethmoidal sinuses* consist of several irregular spaces occupying the lateral masses of the ethmoid, and completed by the frontal, sphenoid, lachrymal, inferior maxillary and palate bones. The *anterior*, the larger and more numerous, open into the middle, the *posterior* into the superior meatus. The *frontal sinuses* are placed between the outer and inner tables of the frontal bone over the root of the nose. They extend outwards from behind the glabella to a variable distance over the orbit, being separated from each other by a thin bony septum. They open into the middle meatuses of the nose through the infundibula. The *sphenoidal sinuses* occupy the body of the sphenoid, being formed in connection with the sphenoidal spongy bones. They are separated by a median septum, and open on the roof of the nose above the superior meatus. The *maxillary sinus* has been described in connection with the superior maxillary bone; it opens by a small aperture into the middle meatus.

Fig. 55.

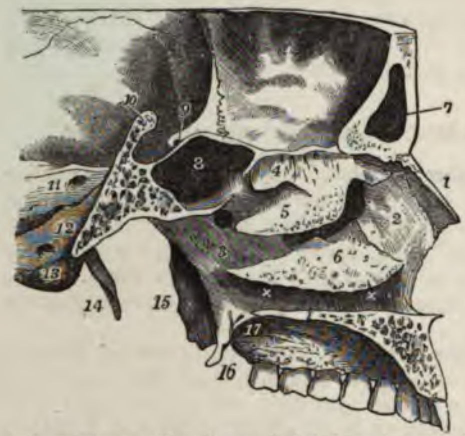

Fig. 55.—Sagittal section of a part of the skull, showing the outer wall of the left nasal fossa, &c. (A.T.) $\frac{1}{2}$

1, nasal bone; 2, nasal process of the superior maxillary bone; 3, vertical plate of the palate bone; 4, superior turbinate bone—below it the superior meatus, behind it the opening into the left sphenoidal sinus; 5, the middle turbinate bone—below it the middle meatus, into which opens the maxillary sinus; superiorly and anteriorly, is the opening of the infundibulum; behind it, and above 3, the spheno-palatine foramen; 6, inferior turbinate bone — below it the inferior meatus × ×; below these marks the section of the palate plates of the left palate and superior maxillary bones; 7, left frontal sinus; 8, left sphenoidal sinus; 9, left optic foramen in the root of the lesser wing of the sphenoid, and anterior clinoid process; 10, dorsum sellæ divided; and between 9 and 10, the sella turcica; 11, posterior surface of the petrous, close to the internal auditory meatus; 12, basilar process of the occipital bone, close to the jugular foramen; 13, below the anterior condylar foramen; 14, left styloid process; 15, external, and 16, internal pterygoid plates; 17, posterior palatine canal.

## OSSIFICATION OF THE BONES OF THE HEAD.

The ossification of the bones of the base of the cranium takes place for the most part in cartilage, and in each case proceeds from several centres which represent distinct bones in the lower vertebrate types; the bones of the roof are simpler in their development and originate in membrane; those of the face are also deposited in membrane, with the exception of the inferior turbinate bone and a small part of the lower jaw. In the expanded tabular bones the ossification spreads outwards from the centres, and the marginal portions, in the earlier stages, present more or less the form of radiated fibres or spicula. At birth the sutural edges, and especially the angles, are incomplete, the bones being united and the interspaces filled up by fibrous tissue. The diploe and sinuses are at first absent, some of the latter arising early in life, and others being formed at a comparatively late but variable period.

The **occipital** bone at birth consists of four separate pieces—a basilar, a tabular, and two condylar parts, united by intervening cartilage. The lines of junction of the basilar and condylar parts pass through the condyles near their anterior extremities; those of the condylar and tabular parts extend outwards from the posterior margin of the foramen magnum. The basilar (basioccipital) and condylar parts (exoccipitals) arise each from one osseous nucleus, which appears in the seventh or eighth week.* In the tabular part there appear, a few days earlier, usually four nuclei, an upper and a lower pair; these speedily unite, but leave fissures running in from the upper and lateral angles, which remain for some time after birth. The upper pair of these differ from the other centres of this bone in being deposited in membrane, and whilst the lower portion of the tabular part is the proper supraoccipital element, the upper represents the interparietal bone of many animals; it occasionally happens that this remains distinct in the human skull, the upper part of the occipital squama being separated from the rest by a suture running transversely from one lateral angle to the other, and by no means unfrequently a partial division exists, by persistence of the lateral fissures, which may even simulate fracture. The osseous union of the supra- and exoccipitals, beginning in the second or third, is completed in the fourth year; that of the basi- and exoccipitals, beginning in the third or fourth, is completed in the fifth or sixth year. The basioccipital is united to the basisphenoid by intervening cartilage up to about the twentieth year, after which ossific union begins and is completed in one or two years.

Fig. 56.

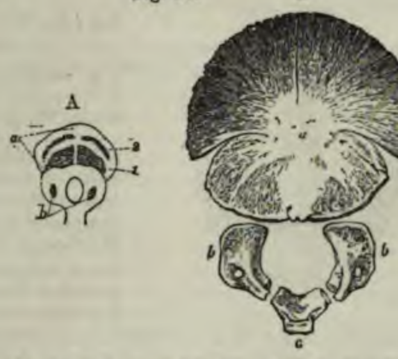

Fig. 56.—Ossification of the occipital bone (R. Quain).

A, in a fœtus of 10 weeks (from Meckel); *a*, tabular part; 1 & 2, lower and upper pairs of centres; *b*, lower part or basilar and condylar portions: ossific centres are seen in the condylar portions.

B, occipital bone at birth; *a*, tabular part, in which the four centres have become united into one, leaving fissures between them; *b*, *b*, condylar portions; *c*, basilar portion.

The **parietal** bone is ossified from a single nucleus, which appears in the situation of the parietal eminence about the seventh week. The eminence is very conspicuous in the young bone, and gives a marked character to the form of the skull for a number of years in early life.

The **frontal** bone is ossified from two nuclei which appear one on each side above the orbital arch, about the seventh week. At birth the bone consists of two separate lateral portions, which meet in

Fig. 57.

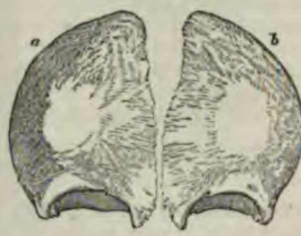

Fig. 57.—Frontal bone of a fœtus shortly before birth (R. Quain).

*a* & *b* indicate the two portions of the bone, in each of which the radiation of bony spicula from the frontal eminence is seen.

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* In the descriptions of the mode of ossification of the bones, weeks and months refer always to periods of fœtal life.

a vertical median suture during the first year. This *frontal suture* usually becomes obliterated by osseous union taking place from below upwards, during the second year, though not unfrequently it persists throughout life. The frontal sinuses appear about the second year, and continue to increase in size up to old age.

The **Fontanelles.** These are membranous intervals between the incomplete angles of the parietal and neighbouring bones, in some of which movements of the soft wall of the cranium may be observed in connection with variations in the state of the circulation and respiration. They are six in number, two median, anterior and posterior, and four lateral. The *anterior* fontanelle, situated between the antero-superior angles of the parietal bones and the superior angles of the ununited halves of the frontal bone, is quadrangular in form, and remains open for some time after birth. The *posterior* fontanelle, situated between the postero-superior angles of the parietal bones and the superior angle of the occipital bone, is triangular in shape. It is filled up before birth, but the edges of the bones, being united by membrane only, are still freely movable upon each other. The *lateral* fontanelles, small and of irregular form, are situated at the inferior angles of the parietal bones. The fontanelles are gradually filled up by the extension of ossification into the membrane which occupies them, thus completing the angles of the bones and forming the sutures. The closure, especially of the posterior and lateral, is often assisted by the development of Wormian bones in these situations. All traces of these unossified spaces disappear before the age of four years.

Fig. 58.

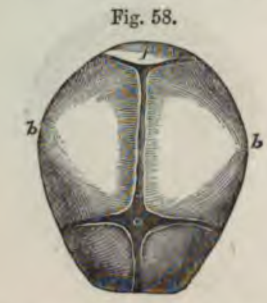

Fig. 58.—Skull of a child at birth, seen from above (from Leishman). ⅓

*a*, anterior fontanelle ; *p*, posterior fontanelle ; *b*, *b*, parietal eminences ; for the lateral fontanelles, see fig. 65, p. 79.

The **temporal** bone in the later stages of fœtal life consists of three principal pieces, the squamo-zygomatic, petro-mastoid, and tympanic. The *squamo-zygomatic* is ossified in membrane from a single nucleus, which appears in the lower part of the squamosal about the seventh or eighth week. From this point ossification extends upwards into the squamosal, and outwards into the zygoma. During the third month an osseous nucleus appears in the lower part of the external membranous wall of the tympanum, and extends upwards forming the *tympanic ring*, an imperfect circle, open superiorly, and which encloses the tympanic membrane. Before birth the extremities of this ring become united with the squamo-zygomatic.

Fig. 59.

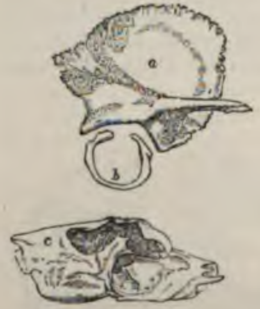

Fig. 59.—Separate parts of the temporal bone of a child at birth (R. Quain).

*a*, squamo-zygomatic ; *b*, tympanic, forming an imperfect ring, open superiorly ; *c*, petro-mastoid, *c* being placed on the mastoid part.

*Petro-mastoid* or *periotic.* The ossification of this part of the temporal bone does not begin so soon as that of the other parts. It is only towards the end of the fifth month and in the course of the sixth that the bony parts of the internal ear begin to appear in the cartilage which precedes them. The osseous deposit takes place at many points, the chief of which are situated in the wall of the labyrinth in connection with the formation of the cochlea and semicircular canals and the different nuclei soon unite. According to Huxley the principal [illegible] come to be disposed so as to form three portions, to which he has given the following names, viz.: 1, *Prootic*, including most of the labyrinth and upper part of the petrous, together with part of the mastoid; 2, *Opisthotic*, comprehending mainly the lower part of the petrous, with the fenestra rotunda and half of the fenestra ovalis; and 3, *Epiotic*, corresponding to the lower part of the mastoid. More recently the mode of ossification of the periotic in man has been studied by A. J. Vrolik, who describes the petrous as being developed from four centres, which are placed around the labyrinth, and have coalesced by the end of the sixth month, while the mastoid part is formed from two independent nuclei, which unite with the petrous before the time of birth (Niederl. Arch. f. Zoologie, i. 291).

At birth the petro-mastoid is separated from the squamosal by a thin plate of intervening cartilage, bony union taking place during the first year; the mastoid portion also is quite flat, the glenoid fossa shallow, the articular eminence scarcely to be seen, and the tympanic ring and membrane are even with the outer surface of the bone. After birth the external auditory meatus is gradually formed by the outgrowth of the united squamous and petro-mastoid portions above and behind, and of the tympanic plate in front and below; the latter is developed from the outer margin of the slender tympanic ring, commencing in the form of two small tubercles at the fore and hinder parts respectively; these increase in size and meet in the floor of the meatus, enclosing a foramen which is gradually closed. The foramen is completed as a rule in the second year, and is seldom obliterated before five years of age. The part of the wall of the meatus which was occupied by the foramen is commonly thin, and frequently a small aperture persists through life. On the posterior surface of the petrous at birth is a considerable depression extending into the arch of the superior semicircular canal, and which represents the floccular fossa of the lower animals; in the adult bone a vestige of this is always present as a small fissure above and outside the internal auditory meatus, between that and the aqueduct of the vestibule. The mastoid process is developed about the second year, but the air-cells are not formed till near puberty.

The styloid process is formed by two small ossifications in cartilage: the *tympanohyal* at the base, commencing before birth and speedily joining the bone, and the *stylohyal* commencing usually after birth, but remaining very small until the period of puberty; this only joins after adult age is reached, and often remains permanently separate (Flower, Brit. Ass. Rep. 1870).

The **sphenoid** bone presents in infancy traces of a natural division into a posterior or *postsphenoid* part, to which the sella turcica and great wings belong, and an anterior or *presphenoid* part, to which belong the body in front of the olivary eminence and the small wings,—a division which is found in many animals complete and persistent through life. The first osseous nuclei of the postsphenoid division appear about the eighth week in the great wings (alisphenoids), between the foramen rotundum and foramen ovale, and spread thence outwards into the wing and downwards into the external pterygoid plate. About the same time also two granules appear in the postsphenoid part of the body (basisphenoid), placed side by side in the sella turcica; these unite about the fourth month, and after their union two others appear, from which are formed the lingulæ (basitemporals), inside which are placed the carotid grooves. The internal pterygoid plates, corresponding to the pterygoid bones of animals, are ossified from distinct nuclei, which are deposited in membrane and appear in the fourth month; they unite with the external pterygoid plates in the fifth or sixth month. The great wings are united to the body in the first year.

In the presphenoid division the first pair of nuclei appear in the eighth or ninth week outside the optic foramina, and extend by their growth into the small wings (orbitosphenoids): another pair of granules appear on the inner sides of the foramina, and the presphenoid portion of the body either results from the union of these, or is an independent growth. The presphenoid is united to the body of the postsphenoid in the seventh or eighth month. The line of union is indicated for some time by a hole filled with cartilage, round above, and opening inferiorly into a wide notch, which is recognisable for several years after birth. The body of the presphenoid is for a year or two broad and rounded inferiorly, but becomes gradually narrower and more prominent: it is separated at first by a layer of fibro-cartilage from the sphenoidal spongy bones.

The *sphenoidal spongy bones* seldom appear till after birth, and are united to the body at the age of puberty. Each is in early life a hollow pyramid formed by the union of three laminæ, viz., an inferior, an external, and a superior; and the sphenoidal sinus subsequently results from the expansion of the cavity thus enclosed. The inferior lamina forms the greater part of what can be distinguished in the adult; the external is that to which the orbital portion belongs; while the superior lamina, forming the inner wall and roof of the original sphenoidal sinus, becomes, as the sinus expands, partly absorbed and partly united to the attenuated body of the presphenoid, which is ultimately reduced to the thin sphenoidal septum and the rostrum.

Fig. 60.

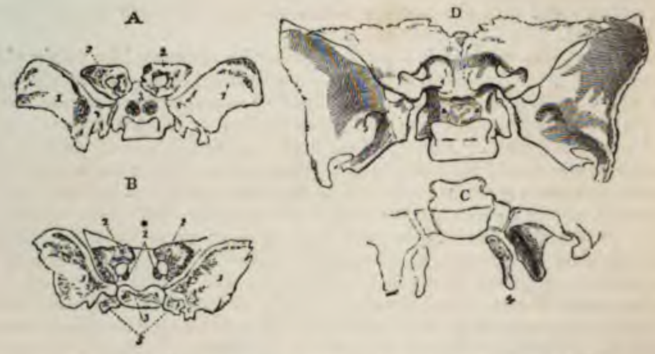

Fig. 60.—Ossification of the sphenoid bone (R. Quain).

A, sphenoid bone at an early period, seen from above; 1, 1′, the greater wings ossified; 2, 2′, the lesser wings, in which the ossification has encircled the optic foramen, and a small suture is distinguishable at its posterior and inner side; 3, two round granules of bones in the body below the sella turcica, the rest being cartilaginous.

B, copied from Meckel (Archiv. vol. i. tab. vi. fig. 23), and stated to be from a fœtus of six months; 2*, additional nuclei for the lesser wings; 5, separate lateral processes of the body (lingulæ): the other indications are the same as in A.

C, back part of the bone shown in A; 4, internal pterygoid plates still separate.

D, sphenoid at birth. The great wings are still separate. The presphenoid is now joined to the basisphenoid, and the internal pterygoid plates (not seen in the figure) are united to the external.

In the **ethmoid** bone ossification commences in the fourth or fifth month, by the appearance of a nucleus in the orbital plates of the lateral masses gradually extending into the turbinate bones. During the first year the vertical and cribriform plates are ossified from a single nucleus, which, spreading outwards, unites with the lateral masses about the beginning of the second year. The ethmoidal cells are not formed till the fourth or fifth year.

The **superior maxillary** bone commences to ossify immediately after the clavicle and the lower jaw. As described by Callender (Phil. Trans. 1869, p. 163), the osseous deposit takes place in many points, appearing first in the orbital plate, the nasal process and the alveolar border, but they speedily fuse, and can not be regarded as separate centres. The part of the bone, however, which carries the incisor teeth, extending as far back as the incisor foramen, has an independent origin, corresponding to the premaxillary bone of the lower animals. In young subjects always, and often in the adult, there is to be seen a fine fissure, *incisor fissure*, on the under surface of the palate process, passing outwards from the anterior palatine canal to the alveolar border, in front of the canine socket; and on the upper surface a similar line may be seen, though less frequently, extending up some distance on the nasal surface of the body; but no trace of the line of union exists on the facial surface, as is the case in the lower animals.

Callender explains this as being due to the development at the lower and fore part of the maxilla of an outgrowth, which he terms the *incisor process*, and which forms the front wall of the incisor sockets ; behind this process, between it and the palate process, is a deep groove in which the premaxillary bone is formed, the latter being distinct up to the fifth month of fœtal life.

The sockets of the teeth are formed by the downgrowth of an outer and an inner plate on the sides of the dental groove, and subsequently the partitions appear, those on each side of the canine tooth first. The antrum appears as a shallow depression on the inner surface of the bone at about the fourth month ; this gradually extends, separating the orbital and palate portions of the bone, which at birth are still very close together. The infraorbital canal begins as a groove on the orbital surface, the margins of which gradually close over, but a fine suture remains indicating the line of meeting.

Fig. 61.

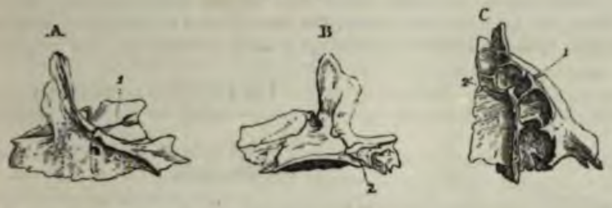

Fig. 61.—Different views of the superior maxillary bone of a fœtus of four or five months (R. Quain).

A, external surface ; a fissure, 1, is seen extending through the orbit into the infra-orbital canal.

B, the internal surface ; the incisor fissure, 2, extends from the foramen upwards through the horizontal plate and some way into the nasal process.

C, the bone from below, showing the imperfect alveoli and the incisor fissure, 2′, 1, which crosses the palate plate, between the second and third alveoli, and passes through the outer part of the bone.

The **palate** bone is ossified from a single centre, which appears in the seventh or eighth week at the angle between its horizontal and ascending parts.

The **vomer** is ossified from a single nucleus appearing at the hinder part about the eighth week. From this nucleus two laminæ are developed, which, passing up on either side of the middle line, embrace the septal cartilage. These laminæ gradually undergo increased union from behind forwards till the age of puberty, thus forming a mesial plate, with only a groove remaining on its anterior and superior margins.

Fig. 62.

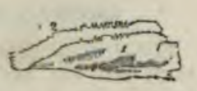

Fig. 62.—The fœtal vomer near the time of birth (R. Quain).

1 & 2 show the two plates of which the bone consists, and which are united behind and below.

The **nasal** and **lachrymal** bones are each ossified from a single centre, which appears about the eighth week.

The **malar** bone also commences to ossify about the eighth week. According to Rambaud and Renault it is developed from three points which have united by the fourth month of fœtal life ; and to the persistent separation of one of these, the divided condition of the bone referred to on p. 53 may be due.

The **inferior turbinate** bone is ossified in cartilage from a single centre, which only appears in the fifth month.

The **inferior maxillary** bone is developed principally in the fibrous tissue investing Meckel's cartilage (see development of the head in Vol. II.), but to a less extent the cartilage itself participates in the ossification. At birth it consists of the lateral parts united at the symphysis by fibrous tissue, the osseous union takes place in the first year. The process of ossification commences very early, being preceded only by the clavicle, and proceeds rapidly: its precise method is still uncertain, but most observers are agreed that it takes place from several centres, which speedily unite. The largest part of each half is formed from a deposit in the membrane on the outer side of Meckel's cartilage, and, according to Callender (*loc. cit.*), there is added on the inner side of this a second smaller plate which forms the floor of the dental groove (subsequently the inferior dental canal) and the inner wall of the tooth-sockets. A small part of the body by side of the symphysis results from the direct ossification of the anterior end of Meckel's cartilage; and, posteriorly, the condyle and a portion of the ramus are developed from another ossification in cartilage. The last, however, is not connected with Meckel's cartilage, which can be seen in a fœtus of the fifth or sixth month to be prolonged up to the fissure of Glaser, where it becomes continuous with the slender process of the malleus, surrounded by fibrous tissue which eventually forms the so-called internal lateral ligament of the jaw. At birth the coronoid process is large, the neck of the condyle short and bent backwards, the ramus also very short and oblique, the angle at which it joins the body of the jaw being about 140°. During the succeeding years the body becomes deeper, thicker, and longer, the ramus and the neck of the condyle lengthen, and the angle at which the ramus joins the body becomes less obtuse, till in the adult it is nearly a right angle. In old age, consequent upon the loss of the teeth and the absorption of the alveolar margin, the body becomes shallower, and the angle is again increased.

Fig. 63.

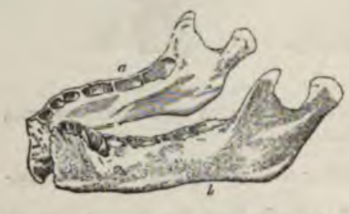

Fig. 63.—THE INFERIOR MAXILLA OF A CHILD AT BIRTH (R. Quain).

*a* & *b* indicate the two portions separate at the symphysis.

The **hyoid** bone has five points of ossification—one for the body, and one for each of its great and small cornua. The ossification begins in the great cornua and body in the last month of fœtal life, in the small cornua in the first year after birth. The great cornua and body unite in middle life, the small cornua only exceptionally in advanced age. The stylo-hyoid ligaments are occasionally ossified in some part of their extent.

## GENERAL MORPHOLOGY OF THE BONES OF THE HEAD.

The circumstances which contribute most to modify the form of the human skull and the condition of its component bones, as compared with that of animals, are—1st, the proportionally large size of the brain and the corresponding expansion of the cranial bones which enclose it; 2nd, the smaller development of the face as a whole, and especially of the jaws, which brings the facial bones almost entirely under the fore part of the brain-case, instead of in front of it, as occurs in all animals, with the partial exception of the anthropoid apes; and 3rd, the adaptation of the human skeleton to the erect posture, which, as regards the head, is attended with the sudden bend of the basicranial axis at a considerable angle upon the line of the erect vertebral column; and along with this the advance of the occipito-vertebral articulation to such an extent as to make the head nearly balanced on the upper extremity of the spine. The downward openings of the nostrils, the forward aspect of the orbits and eyes, the nearly vertical forehead and more or less oval-shaped face, are accompaniments of these human peculiarities in the form of the head, which, together with those already mentioned, strongly contrast with the smaller cranium and its strong crests of bone, ie larger projecting face and jaws, and the other characteristic features of the kull in most animals.

As regards the condition of the individual bones, it is further to be remarked nat there is generally in the human skull a more complete consolidation or bony nion of the osseous elements than in animals, so that the whole number of ones forming the cranium and face is least in man. Thus, to mention only ome of the most marked examples of this difference among mammals; the rontal bone and the lower jaw frequently divided into two lateral portions; the remaxillary very generally a separate bone from the maxillary; the presphenoid i many separate from the postsphenoid; the interparietal from the occipital; ie reduction in size of the squamosal, and its occasional separation from the etrous; the increase in the proportions of the tympanic portion or bulla; and ie very frequent development of bony elements connecting the hyoid bone irectly with the skull. It is also worthy of observation that some of the conditions ow referred to as permanent in animals exist as transitory stages of develop- ient in the fœtus of man.

**Homologies.**—It would be out of place in this work to enter at any length nto the consideration of the homologies of the bones of the human skull,—a ubject which would require a minute reference to embryology and a wide range f comparative anatomy. But as it may be useful at least to show the bearing of uch homological views on human anatomy, there has been introduced here a dia- rammatic figure of the bones of the fœtal head (see fig. 64) and a table of their omenclature, in which an attempt is made to indicate the morphological relations f the several bones to each other and to those of quadrupeds, and an explanation s given of the signification of some of the terms applied by comparative ana- omists to these bones in connection with the names usually given to them in vorks on human anatomy. For fuller information on this subject the reader is eferred to the works of Owen, Goodsir, Huxley, Flower, St. George Mivart, Gegen- aur, and others already quoted.

## CLASSIFIED LIST OF THE BONES OF THE HEAD AND THEIR TYPICAL COMPONENT PARTS*:—

### 1. BONES FORMING THE CRANIO-FACIAL AXIS.

**Mesethmoid**; Vertical plate of the ethmoid bone, including the cartilaginous iasal septum, which is partially enclosed by

**Vomeric** (*m*); The Vomer.

**Presphenoid**; Anterior part of the body of the sphenoid bone.

**Basisphenoid**; Posterior part of the body of the sphenoid bone, including the ella turcica.

**Basioccipital**; Basilar process of the occipital bone.

### 2. BONES FORMING THE LATERAL AND UPPER WALLS OF THE CRANIAL CAVITY.

**Orbitosphenoids**; The lesser wings of the sphenoid bone.

**Frontals** (*m*); United in the single frontal.

**Alisphenoids**; Great wings of the sphenoid with the external pterygoid plates.

**Parietals** (*m*); The parietal bones.

**Exoccipitals**; Condylar portions of the occipital bone.

**Supraoccipital**; Lower portion of the tabular part.

**Interparietal** (*m*), of some animals, corresponds to the upper part of the foregoing.

The temporal bones interposed between the occipitals and sphenoids consist of

**Periotics, or petro-mastoid** bones; The petrous and mastoid portions of the temporal bone; the first including the labyrinth and internal auditory meatus.

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* The names first given, and printed in black type, are those received in comparative anatomy; those usually employed in human anatomy follow, and are printed in common type. The bones which are developed in membrane are indicated by (*m*) following their names; in the others, ossification commences in cartilage.

**Squamosals**, or **squamo-zygomatic** (*m*); The squamous part of the temporal bone with the zygoma, including the articular surface for the lower jaw.

**Tympanics** (*m*); The tympanic plate, forming the auditory and vaginal processes.

### 3. BONES COMPLETING THE FACE AND ENCLOSING THE NOSE, MOUTH, AND PHARYNX.

**Ethmoturbinals**; The lateral masses with the upper and lower turbinate bones of the ethmoid.

**Lachrymals** (*m*); The lachrymal bones.

**Nasals** (*m*); The nasal bones.

**Maxilloturbinals**; The inferior turbinate bones.

**Premaxillary**, or **intermaxillary** (*m*); The incisor part of the superior maxillary bones.

**Pterygoids** (*m*); The internal pterygoid plates.

**Palatals** (*m*); The palate bones.

**Maxillæ** (*m*); The superior maxillary bones, excepting the incisor part.

**Malars**, or **jugals** (*m*); The malar bones.

**Malleus, Incus,** and **Stapes**; The auditory ossicles or malleus, incus, and stapes.

**Mandible** (*m*); The inferior maxilla or lower jaw.

**Stylohyals** with **Tympanohyals**; The styloid processes of the temporal bones.

**Epihyals**; The stylo-hyoid ligaments.

**Ceratohyals**; The small cornua of the hyoid bone.

**Basihyal**; The body of the hyoid bone.

**Thyrohyals**; The great cornua of the hyoid bone.

**Branchial Arches**; These follow the preceding, but are only temporary fœtal structures in man and all vertebrate animals, except amphibia and fishes.

The general correspondence between the bones of the head in man and animals, implied in the names given to them in the foregoing table, is so well ascertained, and, in most instances, so obvious, that it is unnecessary to say more than that it is very generally acknowledged by comparative anatomists, and that it is chiefly on some points connected with the earliest condition, and the homological comparison of a few of the bones, that differences of opinion continue to exist.

Besides the general evidence in favour of the homologies of these bones which has been drawn from the study of their form, position and connections, strong confirmation of these views is also obtained from their relations to other organs. Among these, from the remarkable constancy of their relations, the passage of the nerves out of the cranium is one of the most important. Thus, the nerves belonging to the principal organs of the senses pass into their sense capsules as follows, viz.: the olfactory through the cribriform plate developed in connection with the ethmoturbinal; the optic through the inner part of the orbitosphenoid; the auditory directly into the periotic. Farther, the motor nerves of the eyeball and its muscles, with the ophthalmic division of the trifacial, pass between the orbitosphenoid and alisphenoid; the second and third divisions of the trifacial through the inner part of the alisphenoid; the facial by its descending division through the internal meatus, the so-called aqueduct of Fallopius, and the stylo-mastoid foramen, and by the Vidian nerve, through the pterygoid canal; the glosso-pharyngeal, pneumogastric, and spinal accessory nerves between the petrosal and exoccipital; and the hypoglossal nerve through the condylar foramen of the exoccipital. The internal carotid artery, it may be farther stated, enters the cranium by a canal separated from the foramen lacerum or space between the petrous, basioccipital, and basisphenoid; and the jugular vein issues between the petrous and exoccipital.

A general review of the relations of the bones of the head leads to the conclusion that they may be looked upon as consisting mainly of three sets of parts, viz.: 1st, **Basal or central parts,** comprising the basioccipital, basisphenoid, presphenoid and mesethmoid, which form a series prolonged forwards in the line of the vertebral axis, and constituting a cranio-facial axis; 2nd, **Superior arches,** enclosing the brain, and consisting generally of more or less expanded bones, viz., the exoccipital and supraoccipital together with the interparietal, the alisphenoids, squamosals and parietals, the orbitosphenoids and frontals; and 3rd, **Inferior arches,** surrounding the visceral cavity as represented by the nose, mouth, and pharynx; these include the pterygoids, palatals and maxillæ in a first arch, the mandible and the malleus of the internal ear in a second, the basi-, cerato-, epi-, stylo- and tympanohyals in a third, whilst the thyrohyals are the rudiments of a fourth. To these succeed in the lowest vertebrates the series of

Fig. 64.

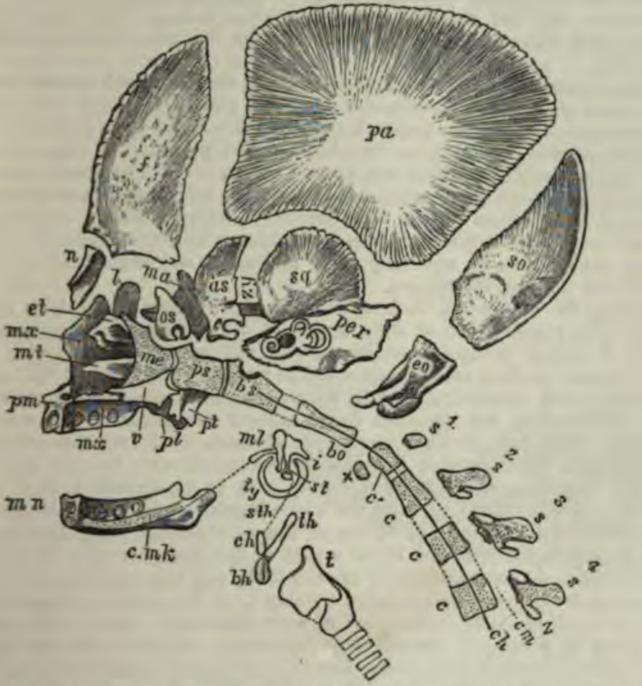


Fig. 64.—Diagrammatic view of the bones in the right half of a fœtal skull from the inside. (A. T.)

In this figure the bones have been slightly separated and displaced so as to bring the whole into one view: *f*, frontal: *pa*, parietal; *so*, supraoccipital; *n*, nasal; *l*, lachrymal; *ma*, malar; *os*, orbitosphenoid; *as*, alisphenoid; *sq*, squamosal; *zy*, zygomatic; *per*, periotic; *eo*, exoccipital; *et*, ethmoturbinal; *mx*, maxilla; *mt*, maxilloturbinal; *pm*, premaxillary; *me*, mesethmoid; *v*, vomer; *pl*, palatal; *pt*, pterygoid; *ps*, presphenoid; *bs*, basisphenoid; *bo*, basioccipital; *c*, bodies of 2nd, 3rd, and 4th cervical vertebræ; *c'*, odontoid process; x, anterior arch of atlas; *s*, spinous processes of 1st, 2nd, 3rd, and 4th cervical vertebræ; *cm*, neural canal; *ch*, a line indicating the position of the notochord passing through the vertebral bodies into base of the cranium, *bs*; *ty*, tympanic, along with *ml*, *i*, and *st*, displaced from its connection with *per*; *ml*, malleus; *c. mk*, cartilage of Meckel; *mn*, mandible; *i*, incus; *st*, stapes; *sth*, stylohyal; *ch*, ceratohyal; *th*, thyrohyal; *bh*, basihyal; *t*, thyroid cartilage.

branchial arches, but which, although indicated in the early embryo, never attain even the cartilaginous condition in man and the higher animals. Together with the foregoing are associated two other sets of elements, viz., 1st, the **Sense capsules** or **cavities**, which are interposed between other bones, and are connected with the lodgment of the higher organs of sense, the nose, eye, and ear; and in the case of the nose (ethmo- and maxilloturbinals), but more especially of the ear (periotic), the capsules are formed of special and complex bony apparatus; and 2nd, **Superadded** or **investing bones**, as the nasal, lachrymal, malar, and vomer, which are extraneous to the more fundamental osseous elements.

**Vertebrate theory of the skull.**—The idea that the skull consists essentially of a series of vertebræ, the superior or neural arches of which have undergone great expansion so as to predominate over the less developed inferior or visceral arches, occurred to Goethe in 1791, but was first published by Oken, by whom it was independently conceived and worked out, in 1807. The theory, however, has undergone various modifications in the hands of the successive comparative anatomists by whom it has been supported, while others of distinction have refused to admit the validity of the grounds on which it has been framed. More recent researches, and especially those of Parker and Gegenbaur, have thrown much new light on the subject.

Among the arguments in favour of this theory, may be specially mentioned here:—the general plan of construction of the skull as above explained, viz., a series of central parts, supporting superior and inferior arches which surround the preaxial portions of the cerebro-spinal nervous centre and of the alimentary canal in a way resembling that in which they are enclosed more postaxially by the vertebræ and the appended costal arches; the origin of the walls of the cranial cavity from the same embryonic elements as the vertebræ; and the prolongation of the notochord in the embryo a considerable distance into the base of the cranium. On the other hand it is to be remarked that the notochord does not extend through the whole length of the cranio-facial axis, but terminates close behind the region of the sella turcica, being directed towards the dorsum sellæ, and thus leaves a part of the basisphenoid, and the whole of the presphenoid and mesethmoid unoccupied by any true central or vertebral axis; also that the superior arches differ notably from the neural arches of the vertebræ, not only in being constructed of more numerous osseous elements, but also in being in great part developed in membrane instead of in cartilage, while the inferior arches, besides being also in part intramembranous ossifications, are formed in much closer connection with the wall of the alimentary canal than the ribs, which are laid down in the body wall or somatopleure. (The fœtal conditions here referred to will be fully explained in the section on Embryology in Vol. II.)

The investigations of the last few years, however, both upon the structure and relations of the head skeleton in its more primitive form, as met with in the lower vertebrates, and upon its mode of development in the embryo, have given strong support to the view that at least the posterior portion of the skull, the part behind the region of the pituitary fossa, has in some degree a vertebrate nature; *i.e.*, that it has had its origin in the coalescence, modification and partial suppression of a series of segments, the number of which is inferred, from the disposition of the visceral arches and of the cranial nerves, to have been considerable, but cannot, in the present state of our knowledge, be precisely determined. To these, other elements, investing bones and dermal ossifications, appear to have been added, giving rise to the membrane bones which constitute the roof of the skull and the anterior visceral arches. As to the origin of the anterior portion of the base of the cranium, and especially as to the nature of the *trabeculæ cranii*, the two bars prolonged forwards from the extremity of the mass investing the notochord, through the region subsequently becoming the sella turcica, and forming by their union in front a mesial plate in which the presphenoid and mesethmoid are developed, the opinions of observers are still divided, some recognizing in them a foremost pair of visceral arches, while others oppose this view. This, however, is only one among several points which require farther elucidation before any system of cranial morphology worthy of general adoption can be formed. (See especially Parker and Bettany, "The Morphology of the Skull," 1877, and various papers by Parker in Phil. Trans.; Kölliker, "Entwicklungsgeschichte," 2nd ed., 1879; Gegenbaur, "Elements of Comparative Anatomy," Eng. Trans., 1878, where also other references are given.)

## THE VARIOUS FORMS OF THE SKULL.

**I. Differences according to Age.**—In the earlier stages of its development the posterior part of the cranium bears a very large proportion to the anterior part; so much so, that in the second month of fœtal life the line of the tentorium cerebelli is vertical to the basis cranii, and divides the cranial cavity almost equally into two parts. The parietal region then increases rapidly in volume, along with the greater development of the cerebral hemispheres; the frontal region next augments; and again, in the latter part of fœtal life, the occipital region increases as the cerebrum extends backwards (Cleland). At the time of birth the parietal region has reached its largest development in proportion to the occipital and frontal regions. The greatest frontal breadth is then smaller in proportion to that between the parietal eminences than afterwards. In the first years of childhood the superior parts of the cranium grow more rapidly than the base. Thus, in the frontal region, the upper part of the frontal bone grows more rapidly than its orbital plates, giving the prominent appearance of the frontal eminences peculiar to children. The face at birth scarcely reaches an eighth of the bulk of the rest of the head, while in the adult it is at least a half (Froriep, "Characteristik des Kopfes nach dem Entwicklungsgesetz desselben," 1845). At the same time that the face increases in bulk, the lower part of the forehead is brought forward by elongation of the anterior cranial fossa, and on the approach of adult age, especially in the male, it becomes still more prominent by the expansion of the frontal sinuses. The face becomes elongated in the progress of growth, partly by increased height of the nasal fossæ and adjacent air-sinuses, partly by the growth of the teeth and the enlargement of the alveolar arches of the jaws. In old age the proportion of the face to the cranium is diminished by the loss of the teeth and absorption of the alveolar portions of the jaws. In consequence of this the upper jaw retreats, while in the lower jaw the same cause gives, especially when the mouth is closed, a greater seeming prominence to the chin.

Fig. 65.

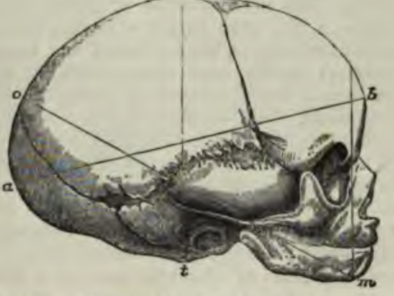


Fig. 65.—Lateral view of the child's head at birth. (From Leishman.) ½

This figure shows the elongated form of the skull in the infant, and the small proportion which the facial bears to the cranial part, and also the lateral fontanelles at the lower angles of the parietal bones. The lines indicate the various diameters.

**II. Sexual Differences.**—The female skull is, in general, smaller, lighter, and smoother than that of the male; the muscular impressions are not so strongly marked, the mastoid processes and the superciliary ridges are less prominent, and the frontal sinuses less developed. The cranial capacity is less, on the average, by one-tenth, than that of the male in the same race, and the frontal and occipital regions are less capacious in proportion to the parietal (Huschke). The face is smaller in proportion to the cranium, the zygomatic arches slender, and the jaws narrower and less prominent. The female skull resembles the young skull more than that of the adult male; but it must also be admitted that it is often impossible to determine the sex by the appearance or form of a skull.

**III. Race Differences, their Measurement and Classification, Craniometry.**—The determination and measurement of the differences in form presented by the skull in the various races of mankind have in recent years engaged the attention of many anatomists in this and other countries, and a system of craniometry has been developed, by means of which the nature and degree of these differences can be precisely stated and formulated. This system is in its principles now generally followed, but there is still much difference of opinion as to many of the details, especially as to the best modes of taking several of the measurements, and a greater uniformity amongst observers in this respect is much to be desired. In the brief sketch here given the methods of measurement and classification recommended are those used by Professor Flower, as explained by him in the Hunterian Lectures during the years 1877 to 1880, and published in the "Catalogue of the Museum of the Royal College of Surgeons," part i., 1879, from which also most of the examples cited have been taken; the measurements of the Andamanese skulls are from a separate memoir by the same author in the "Journal of the Anthropological Institute," 1879. For further information the reader is referred to Topinard, "Anthropologie," Paris, 1876, and especially Broca "Instructions craniologiques et craniométriques," Paris, 1875.

The first place in importance is necessarily occupied by the capacity of the cranium, as affording the most convenient indication of the development of the brain. This is ascertained by filling the cranial cavity through the foramen magnum, the other apertures having previously been stopped, with some small-grained substance, mustard seed has been found to give the most accurate and constant results, and then measuring the quantity contained in a properly graduated vessel, precautions being taken to ensure an equal pressure in both operations. The capacity of the normal human cranium varies from 1000 to 1800 cubic centimeters (about 60 to 110 cubic inches), with an average in all races of 1400 cubic centimeters (85 cubic inches). Skulls with a capacity of from 1350 to 1450 cubic centimeters are placed in a middle group and termed mesocephalic, those exceeding 1450 cubic centimeters in capacity are megacephalic, and those below 1350 cubic centimeters are microcephalic. The following examples are of males only; the figures in brackets after the names indicate the number of skulls examined, and of which the average is taken.

| Cranial Capacity. | Cub. centim. | Cub. inches. |
|---|---|---|
| Eskimo (17) | 1546 | 94·3 |
| English (24, mostly of lowest class) | 1511 | 92·2 |
| Chinese (16) | 1424 | 86·9 |
| African Negroes (26) | 1388 | 84·7 |
| Native Australians (32) | 1298 | 79·2 |
| Andaman Islanders (11) | 1244 | 75·9 |

Before proceeding to the consideration of the linear measurements it is necessary to refer to certain definite points on the surface of the skull from which such measurements are taken, or which have a particular importance as presenting varieties of more or less frequent occurrence, and to which special names have been given, for the most part by Broca, not of ordinary use in descriptive anatomy. The most important of these are:—

*Alveolar point* (fig. 66, A).—The centre of the anterior margin of the upper alveolar arch.

*Subnasal* or *spinal point* (S).—The middle of the inferior border of the anterior nasal aperture at the base of the nasal spine.

*Nasion* or *nasal point* (N).—The middle of the naso-frontal suture.

*Ophryon* or *supraorbital point* (Op).—The middle of the supraorbital line, which, drawn across the narrowest part of the forehead, separates the face from the cranium.

*Bregma* (Bg).—The point of junction of the coronal and sagittal sutures.

*Obelion* (Ob).—The region situated between the two parietal foramina where the sagittal suture is more simple than elsewhere, and where its closure generally commences.

*Lambda* (L).—The point of junction of the sagittal and lambdoid sutures.

*Occipital point* (O).—The point of the occiput in the mesial plane most removed from the Ophryon.

*Inion* (I).—The external occipital protuberance.

*Opisthion.*—The middle of the posterior margin of the foramen magnum.

*Basion* (B).—The middle of the anterior margin of the foramen magnum.

*Pterion* (Pt.).—The region, near the anterior part of the temporal fossa, where the great wing of the sphenoid, the squamous, the parietal and the frontal bones approach each other, the exact disposition, however, varying in different individuals. In the most common condition the parietal and great wing of the sphenoid meet and form a short horizontal suture (p. 58), but it sometimes happens that these two bones are separated by the junction of the frontal and squamous, giving rise to a vertical fronto-temporal suture, usually continuing the line of the coronal suture. The latter form is especially frequent in some of the lower races of mankind, and is the usual condition in the gorilla and chimpanzee. There is often a small Wormian bone in this situation, *epipteric bone* of Flower, and many cases of the occurrence of a fronto-temporal suture are attributable to the union of this piece of bone with the squamous or frontal.

Fig. 66.

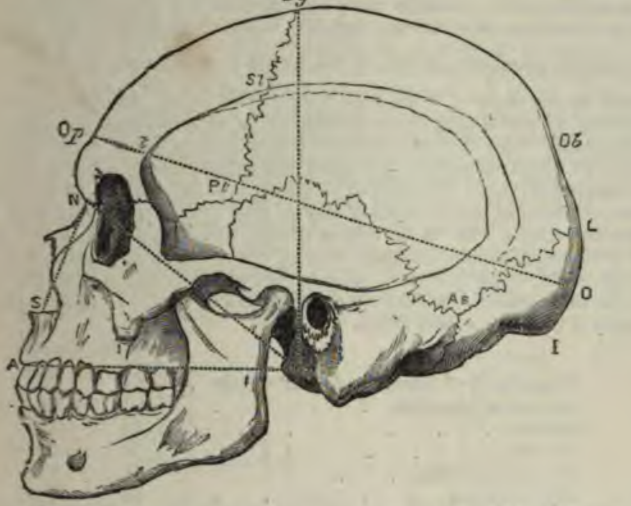


Fig. 66.—Side view of skull of a male Australian. (After Flower.)

A, alveolar point; S, subnasal point; N, nasion; Op, ophryon; Bg, bregma; Ob, obelion; L, lambda; O, occipital point; I, inion; B, basion; Pt, pterion; St, stephanion; As, asterion; Op O, length of cranium; B N, basinasal length; B A, basialveolar length; N S, nasal height.

*Stephanion* (St.).—The point where the coronal suture crosses the temporal line.

*Asterion* (As.).—The point where the lambdoid, parieto-mastoid and occipito-mastoid sutures meet. When a separate interparietal bone is present the suture dividing it from the supraoccipital runs transversely from asterion to asterion, which will in that case be the meeting point of four sutures.

*Auricular point.*—The centre of the orifice of the external auditory meatus.

The chief measurements of the cranium are the circumference, the length, breadth, and height. Of these the first is stated absolutely, while the others are expressed relatively, *i.e.*, the proportion of the breadth and height respectively to the length, such mode of expression being known as an index.

The circumference (horizontal) is taken in a plane passing anteriorly through the ophryon, and posteriorly through the occipital point (fig. 66, O*p* O). This may exceed to a slight degree 550 millimeters (21.7 inches) or it may be as low as 450 mm. (17.7 inches). For comparison of the relative development of the anterior and posterior portions of the cranium, the preauricular part of the circumference is divided from the postauricular part by a line on each side passing from the auricular point to the bregma (*auriculo-bregmatic line*).

The length of the cranium is measured from the ophryon to the occipital point (fig. 66, O*p* O), and this is made the standard=100. The breadth is, in the examples given below, always the greatest interparietal breadth, but many anthropologists, with probably more reason, take the greatest breadth of the cranium above the level of the zygoma, whether it be over the parietals or squamous; the proportion of this to the length is calculated, $\frac{100 \times \text{breadth},}{\text{length},}$ and the result is the *index of breadth* or the *cephalic index*. Skulls with a breadth-index above 80 are brachycephalic, from 75 to 80 mesaticephalic, and below 75 dolichocephalic. This character exhibits a very wide range of variation, it therefore early attracted attention, and upon it Retzius founded a primary classification of skulls; its value, however, in this respect is not so great as was supposed, since the extremes of dolichocephaly and of brachycephaly are met with in races that are shown otherwise to be nearly allied. The height is measured from the basion to the bregma, and the proportion of this to the length, calculated in the same way, is the *index of height*. It is subject to less variation than the breadth-index; in some cases, especially in dolichocephalic skulls, it exceeds, but more frequently it falls below that index.

| | Breadth-index. | Height-index. |
|---|---|---|
| Mongolians of Siberia and Central Asia | 88 | 73 |
| Andaman Islanders | 82 | 77 |
| Chinese | 79 | 75 |
| English | 76 | 71 |
| Native Australian | 71 | 71 |
| Fiji Islanders | 66 | 74 |

For a more accurate determination of the form of the cranium other measurements are taken, such as the transverse circumference, passing through the auricular point on each side and the bregma above; the longitudinal arc from the nasion to the opisthion, with its subdivisions into frontal, parietal and occipital arcs; transverse arcs from the posterior root of the zygoma immediately above the auricular point of the one side to the other, across the most prominent parts of the frontal, parietal, and occipital bones respectively. The antero-posterior curve of the roof may also be indicated by a series of radii from the basion to the centre of the frontal bone, the bregma, the vertex and the lambda. Other features again are not capable of being expressed in terms of direct measurement, and must be described in each case; for example, the form of the transverse arch of the cranium, which in the best shaped skulls is full and rounded, whilst in some races, notably in the Australian, the line of the sagittal suture is elevated, and the surface on each side flattened or even somewhat depressed, making the calvaria roof-shaped; and this condition, combined with great prominence of the parietal eminences or of the temporal lines, gives the skull, when viewed from behind, a markedly pentagonal figure. The degree of complication and fusion of the sutures, the amount of projection of the glabella and of the inion, and other variable points, may be stated according to tables furnished by Broca in the work above referred to.

The situation and direction of the foramen magnum differ greatly, as was pointed out by Daubenton, in man and the lower animals, in connection with the altered position of the axis of the head in relation to that of the vertebral column. In man the foramen is placed in or near the centre of the base of the skull, and its plane looks mainly downwards, in quadrupeds it is placed on the posterior surface of the skull and looks backwards, while in the anthropoid apes it is intermediate in position and direction. But even in human skulls similar differences occur, though much less in degree. In the European the plane of the foramen is inclined upwards anteriorly, in the Australian and Negro it is horizontal or even inclined slightly upwards posteriorly. The degree of inclination requires for its determination a special "occipital goniometer" designed by Broca.

In the skeleton of the face the most striking differences are met with in the size of the jaws and the extent to which they project forwards. The human skull, in comparison with that of the lower animals, is especially distinguished by the great expansion of its cranial portion and the relatively small development of the face, the latter being extended vertically instead of horizontally, and thus brought downwards under the fore part of the cranium. A marked prominence of the jaws constitutes, therefore, an approach to the animal type of skull, and is to be regarded as a character of inferiority, particularly when it is accompanied, as is often the case, by a low and receding forehead. The degree of projection of the jaws beyond the cranium is usually measured by the *facial angle*, originally designed by Camper, but since variously modified by different anatomists. The most serviceable form of the facial angle is that included between two lines meeting at the alveolar point, the one passing through the ophryon and the other through the auricular point, the *ophryo-alveolo-auricular* angle. The character is also estimated more conveniently, and with greater accuracy, by the method of Professor Flower, who compares the basialveolar length (fig. 66, BA) with the basinasal length (BN) = 100, the result giving the *gnathic* or *alveolar index;* skulls with a gnathic index below 98 are orthognathous, from 98 to 103 mesognathous, and above 103 prognathous.

| | Gnathic Index. |
|---|---|
| English . . . . . . | 96 |
| Chinese . . . . . | 99 |
| Eskimo . . . . . . | 101 |
| Fijian . . . . . . | 103 |
| Native Australian . . . | 104 |

In the osseous framework of the nose, and in the form of the anterior nasal aperture, variations are to be recognised corresponding to the external conformation of that feature. Of these, the height and width are capable of exact measurement, and the relation between the two, expressed by the *nasal index* of Broca, becomes a character of considerable importance. The height is measured from the nasion to the subnasal point (fig. 66, NS), the width is the greatest transverse diameter of the anterior nasal aperture, and the calculated proportion of this to the height = 100, is the index. With a nasal index below 48 a skull is leptorhine, from 48 to 53 mesorhine, above 53 platyrhine.

| | Nasal Index. |
|---|---|
| Eskimo . . . . . . | 44 |
| English . . . . . . | 46 |
| Chinese . . . . . . | 50 |
| Native Australian . . . | 57 |

The form of the orbit also varies, but is a less significant character than that of the nose. The *orbital index* is the ratio of the vertical height of the base of the orbit to the transverse width = 100; if above 89 it is megaseme, between 89 and 84 mesoseme, and below 84 microseme.

| | Orbital Index. |
|---|---|
| Andaman Islander . . . . | 91 |
| Chinese . . . . . . | 90 |
| English . . . . . . | 88 |
| Native Australian . . . | 81 |
| Guanches of Teneriffe . . | 80 |

For an account of the variations in the form of the palate and of the mandible, as well as of the naso-malar angle of Flower, by which the degree of forward projection of the malar bones is estimated, and several other measurements of the face skeleton, reference must be made to the special treatises.

(On the foregoing subject consult, in addition to the works of Camper, Cuvier, Blumenbach, Lawrence, Carpenter, and those quoted above, the following: viz., Transl. of the Memoir of Retzius in the Brit. and For. Med. Chir. Rev. 1860; Owen, in Trans. Zool. Soc., vol. iv., 1851; Busk's papers in Trans. Ethnol. Soc. Lond. vol. i., 1861, and Journ. of Anthrop. Inst., vol. iii.; Huxley's Lect. "Man's Place in Nature," and in Journ. of Anat. and Physiol., vols. i. and ii.; Thurnam and Barnard Davis, "Crania Britannica," and B. Davis, "Thesaurus Craniorum," 1867; Cleland in Philos. Trans., 1869; Virchow, "Development of the Cranial Basis," 1857, and in Germ. Quart. Mag. Nov. 1871; Huschke, Schädel, Hirn, und Seele, &c., 1854; Lucae, Zur Morphol. der Rassenschädel, 1861-64; de Quatrefages and Hamy, "Crania Ethnica," 1873-81).

**IV. Irregularities of Form.**—The most frequent irregularity in the form of the skull is want of symmetry. This sometimes occurs in a marked degree, and there is probably no skull perfectly symmetrical. The condition which has been observed to co-exist most frequently with irregular forms of skull is *synostosis*, or premature obliteration of certain of the sutures. The cranial bones increase in size principally at their margins; and when a suture is prematurely obliterated the growth of the skull in the direction at right angles to the line of suture may be supposed to be checked, and increased growth in other directions may take place to supply the defect. Thus the condition known as *scaphocephaly* is found associated with absence of the sagittal suture, where, the transverse growth being prevented, a great increase takes place in the vertical, and especially the longitudinal directions, giving the vault of the skull a boat-like form. The oblique deformity or *plagiocephaly* also is met with in connection with premature fusion of one half of the coronal or lambdoid suture, but independently of this a precisely similar deformity may be induced by rickets, wry-neck, or external pressure. (See Huxley, *loc. cit.;* Virchow, "Gesammelte Abhandlungen," 1856; J. Barnard Davis, "On Synostotic Crania," 1865; W. Turner in Nat. Hist. Rev., 1864.) Another series of irregular forms of skull is that produced by pressure artificially applied in early life, and is best exemplified from among those American tribes who compress the heads of their children by means of an apparatus of boards and bandages: it is also illustrated in a slighter degree by individual instances in which undue pressure has been employed unintentionally. (Gosse, "Essai sur les Déformations artificielles du Crane," 1855.) Posthumous distortions likewise occur in long-buried skulls, subjected to the combined influence of pressure and moisture. (Wilson, "Prehistoric Annals of Scotland.")

## IV.—BONES OF THE UPPER LIMB.

The upper limb consists of the shoulder, the arm, *brachium*, the fore-arm, *antibrachium*, and the hand, *manus*. The bones of the shoulder are the clavicle and scapula, which together form the pectoral arch or *shoulder girdle*; in the arm is the humerus; in the forearm are the radius and ulna; and in the hand three groups of bones, viz., the carpus, metacarpus, and phalanges.

### THE CLAVICLE.

The **clavicle** or collar-bone extends outwards and backwards, from the summit of the sternum to the acromion process of the scapula, and connects the upper limb with the trunk. It is curved like an italic *f*: the internal curve has its convexity directed forwards, and extends over two-thirds of the length of the bone; the outer curve is concave forwards, corresponding to the hollow between the chest and shoulder.

clavicle is broad towards its scapular end, being compressed from above downwards, but in the extent of its inner curve it is more or less prismatic or cylindrical. In its description, four surfaces may be distinguished, together with the two extremities.

Fig. 67.

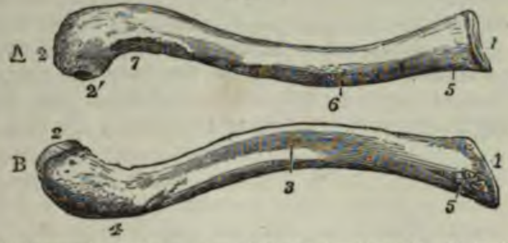


Fig. 67.—The right clavicle. (A. T.) $\frac{1}{3}$

A, from above; B, from below.

1, sternal end; 2, acromial end; 2′, facet for articulation with the acromion; 3, groove on the lower surface for the subclavius muscle; 4, conoid tubercle and trapezoid line; 5, rough mark for the attachment of the costo-clavicular or rhomboid ligament; 6, impression of the pectoralis major; 7, that of the deltoid muscle.

The *superior surface* is broadest in its outer part; it is principally subcutaneous, but near the inner extremity presents a slight roughness, marking the clavicular attachment of the sterno-cleido-mastoid muscle. The *anterior surface* opposite the outer curve is reduced to a mere rough border, from which the deltoid muscle takes origin, but in the inner half of its extent is broadened out into an uneven space more or less distinctly separated from the inferior surface, and giving attachment to the pectoralis major muscle. The *posterior surface* is broadest at the inner extremity, and smooth in the whole extent of the internal curvature; but towards its outer extremity it forms a thick border which gives attachment to the trapezius muscle. About the middle of this surface is the aperture of a small canal for the medullary artery, directed outwards. On the *inferior surface*, at the sternal end, is a rough impression for the attachment of the costo-clavicular ligament; more externally is a groove, extending over the middle third of the bone, in which the subclavius muscle is inserted; beyond this, projecting on the posterior border at the junction of the middle and outer thirds, is a broad tubercle, *conoid turbercle*, to which the conoid division of the coraco-clavicular ligament is attached, and from which the rough, generally raised, *trapezoid line*, for the trapezoid part of the same ligament, is directed outwards and forwards towards the end of the bone.

The *sternal end* is the thickest part of the clavicle. It presents a somewhat triangular concavo-convex surface, with its most prominent angle directed downwards and backwards. The *scapular end* is broad and flat, and articulates by a small oval surface with the acromion.

The interior of the clavicle contains coarse cancellated tissue in its whole extent. Towards the middle the spaces sometimes widen out, and unite so as to form an irregular medullary cavity.

The clavicle is subcutaneous to a greater or less extent in its whole length; the most prominent part is about the centre, corresponding to the intermuscular intervals, above between the sterno-mastoid and trapezius, and below between the pectoralis major and deltoid (*supra- and infraclavicular fossæ*). The outer extremity is a little higher than the upper surface of the acromion against which it fits, and forms a prominence on the upper part of the shoulder.

## THE SCAPULA.

The **scapula** is placed upon the upper and back part of the thorax, and forms the posterior part of the shoulder-girdle. It is not attached directly to the trunk, but is articulated with the outer end of the clavicle, and from it is suspended the humerus in the shoulder-joint.

It consists of a triangular blade or *body*, supporting two large processes. The surfaces of the body are anterior and posterior; the borders superior, internal or vertebral, and external or axillary; the angles superior, inferior, and external; the last, being the thickest part of the bone, and bearing the large articular surface, is distinguished as the *head*, and is supported upon a *neck*. The processes are an anterior, *coracoid process*, and a posterior, the *spine*, which is produced into the *acromion*.

Fig 68 *a*.

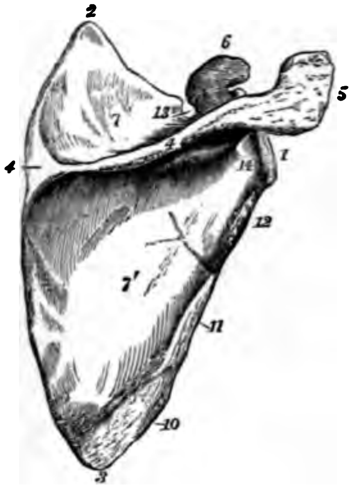


Fig. 68 *b*.

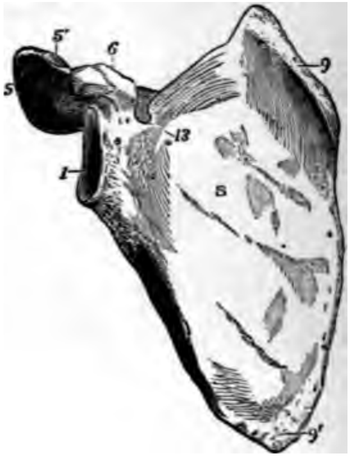


Fig. 68 *a*.—RIGHT SCAPULA FROM BEHIND. (A.T.) ½

1, head and glenoid cavity; 2, superior angle; 3, inferior angle; 4, spine; 4, at the base, triangular smooth surface of the spine; 5, acromion; 6, coracoid process; 7, supra-spinous fossa: 7', infraspinous fossa; 1 to 2, superior border; 2 to 3, vertebral border; 1 to 3, axillary border; 10, oval surface of origin of the teres major muscle; 11, oblique impression for the teres minor muscle; 12, the rough ridge where the long head of the triceps rises; 13, suprascapular notch; 14, neck, below the great scapular notch.

Fig. 68 *b*.—RIGHT SCAPULA FROM BEFORE. (A.T.) ½

1, 5, 6, and 13, as in fig. 68 *a*; 5' articular facet on the acromion for the clavicle; 8, subscapular fossa; 9, 9', surfaces giving attachment to the upper and lower parts of the serratus magnus muscle.

The *anterior surface* or *venter*, looking also considerably inwards, presents a concavity, the *subscapular fossa*, occupied by the subscapularis muscle, and marked by oblique prominent lines converging upwards and outwards, which give attachment to the tendinous intersections of that muscle. Separated from this concavity, are two smaller flat surfaces;

one in front of the superior angle and another at the inferior angle, and these, together with a line running close to the vertebral border and uniting them, give attachment to the serratus magnus muscle.

The *posterior surface* or *dorsum* is divided by the spine into two unequal parts, the upper of which is the *supraspinous fossa*, the lower is the *infraspinous fossa*. The supraspinous fossa is occupied by the supraspinatus muscle. The infraspinous fossa, much the larger, presents in the middle a convexity corresponding to the concavity of the venter, and outside this a concavity bounded by the prominent axillary border. It is marked near the inner border by short lines, corresponding to tendinous septa of the infraspinatus muscle, and is occupied by that muscle in the greater part of its extent. Adjacent to the axillary border, in its middle third, is a narrow interval giving attachment to the teres minor muscle; and beneath this, extending over the inferior angle, is a raised oval surface, from which the teres major arises. These spaces are separated from each other and from that of the infraspinatus muscle by lines which give attachment to aponeurotic septa.

The *spine* of the scapula is a massive triangular plate of bone projecting backwards and upwards from the dorsum. Commencing at the internal border near its upper fourth, it extends outwards and a little upwards to the middle of the neck of the scapula, and becoming gradually elevated towards its external extremity, it turns forwards and is continued into the acromion process. The upper and lower surfaces, smooth and concave, form part respectively of the supra- and infraspinous fossæ. It presents two unattached borders, the more prominent of which is subcutaneous and arises from the vertebral border of the bone by a smooth, flat, triangular surface, over which the tendon of the inferior part of the trapezius muscle glides, as it passes to be inserted into a rough thickening beyond. In the rest of its extent this border is rough, broad, and serpentine, giving attachment by its superior margin to the trapezius, and by its inferior to the deltoid muscle. The external border, short, smooth, and concave, arises near the neck of the scapula, and is continuous with the under surface of the acromion, enclosing the *great scapular notch* between it and the neck of the bone.

The *acromion process*, projecting outwards and forwards from the extremity of the spine over the glenoid cavity, forms the summit of the shoulder. It is an expanded process, compressed from above downwards. Its superior surface, rough and subcutaneous, is continuous with the prominent border of the spine; its inferior surface, smooth and concave, is continuous with the superior surface and external border of the spine. On its internal border anteriorly is a narrow oval surface for articulation with the clavicle.

The *head* bears the articular surface for the humerus, known as the *glenoid cavity*. This is a slightly concave surface, looking outwards, forwards, and slightly upwards. It is pyriform in shape, with the narrow end uppermost, and gently incurved in front. Its rim is flattened, and in the recent state is covered by a fibrous band, the glenoid ligament, which deepens its concavity; at its upper extremity is a small mark indicating the attachment of the long head of the biceps muscle.

The *neck*, supporting the head, is most distinct posteriorly, where it forms with the spine the *great scapular notch*, leading from the supraspinous to the infraspinous fossa; its position is also marked superiorly by the notch in the upper border.

The *coracoid process*, thick, strong, and hook-like, rises for a short distance almost vertically from the upper border of the head, and then bending at a right angle, is directed forwards and slightly outwards. Its superior surface, towards the base, is rough and uneven, giving origin to the coraco-clavicular ligament; on its outer border is attached the coraco-acromial ligament, at its extremity the coraco-brachialis muscle and short head of the biceps, and on the inner edge the pectoralis minor.

The *borders* of the scapula are three in number. The *superior* border is the shortest; it extends from the superior angle outwards and downwards to the coracoid processs, at the base of which it presents a rounded *suprascapular notch*, which is converted into a foramen by a ligament or occasionally by a spiculum of bone, and is traversed by the suprascapular nerve. The *axillary* border is the thickest; at the upper end, below the glenoid cavity, it presents a strong rough mark, above an inch long, to which the long head of the triceps muscle is attached; and below this there is usually a slight groove, where the dorsal branch of the subscapular artery passes backwards; on the ventral aspect of this edge in the greater part of its length is a marked groove in which a considerable part of the subscapularis muscle arises. The *vertebral* border, called also the *base*, is the longest of the three, and is divisible into three parts, viz., a short one opposite the triangular surface of origin of the prominent border of the spine, and the portions above and below that space, both of which incline outwards as they recede from the spine. The upper part gives attachment to the levator anguli scapulæ muscle, the middle to the rhomboideus minor, and the lower to the rhomboideus major muscle.

The body of the scapula is in great part thin and translucent, and contains little cancellated tissue. The head, the coracoid and acromion processes, the prominent border of the spine, and the thick rib along the axillary border, derive their greater thickness and strength from increased thickness of the compact bony substance in some parts, and from cancellated tissue in others. Vascular foramina pierce the upper and lower surfaces of the spine, and others are to be found on the anterior surface of the bone, near the neck.

The subcutaneous parts of the scapula are the free border of the spine in nearly the whole of its length, the upper surface of the acromion, and a small part of the vertebral border in its lower half; the superior and axillary borders are entirely concealed by the muscles. The coracoid process projects in front beyond the clavicle, and can be readily felt inside the head of the humerus, but can be seen only in very thin persons. With the arm hanging by the side the scapula covers the ribs from the second to the seventh inclusive, sometimes the eighth, and the root of the spine is on a level with the interval between the third and fourth dorsal spines; but it is to be remembered that the bone changes its position with every movement of the arm.

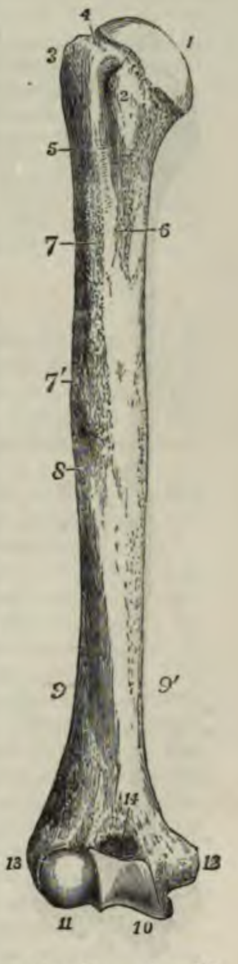
## THE HUMERUS.

The **humerus** or arm-bone extends from the shoulder to the elbow, where it articulates with both bones of the forearm. It is divisible into the *superior extremity*, including the *head*, *neck*, and *great* and *small* *tuberosities;* the *shaft;* and the *inferior extremity,* including the *external* and *internal condyles,* and the *inferior articular surface.* In general form it is subcylindrical and slightly twisted.

Fig. 69.—Right humerus from before. (A. T.) $\frac{1}{3}$

1, head; 2, small tuberosity; 3, great tuberosity; 4, anatomical neck; 5, bicipital groove, the line is at the level of the so-called surgical neck; 6, inner edge of the bicipital groove, and mark of attachment of the latissimus dorsi and teres major muscles; 7, pectoral ridge, running down into 7′, the deltoid impression; 8, spiral groove; 9, external, 9′, internal supracondylar ridge; 10, trochlear articular surface; 11, capitellum; 12, internal condyle; 13, external condyle; 14, coronoid fossa.

Fig. 69.



The *superior extremity* is the thickest part of the bone. The *head* is a large hemispherical articular elevation, directed inwards, upwards, and backwards. The *neck,* as described by anatomists, is the short portion of bone which supports the head; inferiorly, it passes into the shaft; superiorly, it is a mere groove between the head and the great tuberosity. The *great tuberosity* is a thick projection, continued upwards from the external part of the shaft, and reaching nearly to the level of the upper margin of the head; it is surmounted by three flat surfaces, the uppermost of which gives attachment to the supraspinatus muscle, the lowest to the teres minor, and the intermediate one to the infraspinatus muscle. Separated from the great tuberosity by the commencement of the bicipital groove is the *small tuberosity,* oval and prominent; it looks forwards and gives attachment to the subscapularis muscle.

The *shaft* or *body,* thick and cylindrical superiorly, becomes expanded transversely and somewhat three-sided inferiorly. It is divided into anterior and posterior faces by lateral lines, slightly marked in the upper part, but more prominent in the lower, where they pass into the supracondylar ridges. Superiorly on its anterior aspect is the *bicipital groove,* so named from lodging the long tendon of the biceps muscle: this groove, commencing between the tuberosities, descends with an inclination inwards, and is bounded by two rough ridges, the external and more prominent of which, *pectoral ridge,* gives attachment to the pectoralis major muscle, the internal to the latissimus dorsi and teres major. Towards the middle of the shaft, on the inner lateral line, is a rough linear mark where the coraco-brachialis muscle is inserted, and lower down there is a medullary foramen directed downwards into the interior of the bone. On the external part of the shaft, near its middle, in a line anteriorly with the pectoral ridge, is a large, rough, and uneven surface, of a triangular shape, the *impression of the deltoid muscle.* Below this the ridge is continued into a smooth elevation which, descending on the front of the shaft to the inferior extremity, separates an external from an internal surface; while at the sides these are separated from the flat posterior surface by the *supracondylar ridges,* which descend, the external more prominent than the internal, to the condyle on each side.

About the middle of the shaft externally, a broad depression, the *spiral groove,* winds downwards and forwards, limited above by the deltoid impression and below by the external supracondylar ridge, and lodges the musculo-spiral nerve and the superior profunda vessels.

Fig. 70.

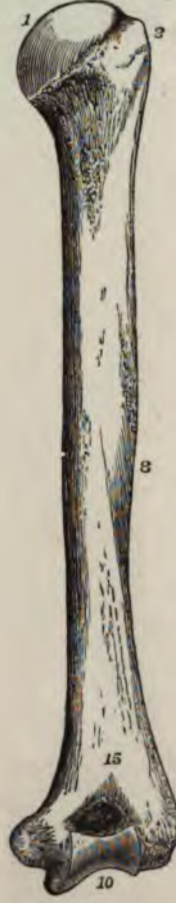


Fig. 70.—Right humerus from behind. (A. T.) ⅓

1, 3, 8, & 10, the same as in Fig. 69; 15, is placed above the olecranon fossa.

The *inferior extremity* is much enlarged laterally, flattened from before backwards, and is curved slightly forwards. Projecting on either side are the *external* and *internal condyles* (the *epicondyle* and *epitrochlea* of Chaussier), the internal of which is much more prominent than the external, and is slightly inclined backwards. The *inferior articular surface* is divided into two parts. The external part, articulating with the radius, consists of a rounded eminence directed forwards, called the *capitellum,* and a groove internal to it; it does not extend to the posterior surface. The internal part, the *trochlea,* articulates with the ulna, and extends completely round from the anterior to the posterior surface of the bone; it is grooved in the middle like the surface of a pulley, and is somewhat broader behind than in front; anteriorly, its margins are inclined downwards and inwards; posteriorly, upwards and outwards, so that, seen from behind, it occupies the middle part of the bone. Anteriorly, the internal margin of the trochlea is the more prominent, and forms a convexity parallel to the groove; posteriorly, the external margin is slightly more prominent. Above the trochlea posteriorly is a large and deep pit, the *olecranon fossa,* which receives the olecranon process of the ulna in extension of the forearm; and above it anteriorly, separated from the olecranon fossa only by a thin lamina of bone, is the much smaller *coronoid fossa,* which receives the coronoid process in flexion. Above the capitellum is a shallow depression, into which the head of the radius is pressed in complete flexion.

The humerus, in its natural position, with the arm hanging by the side, has a slight inclination from above downwards and inwards, and is also in a condition of what may be termed strong internal rotation, *i.e.,* the so-called anterior surface looks very much inwards, and the internal is directed more backwards than inwards. The bone is almost covered by muscles; the head is thickly covered by the deltoid, which it pushes up, and thus gives roundness to the shoulder; the shaft is entirely surrounded; both condyles are subcutaneous, the internal being prominent, whilst the appearance of the external varies as the forearm is moved. When the elbow is bent the capitellum projects under its muscular covering and forms the rounded prominence outside the point of the elbow.

*Varieties.*—A small hook-like process, with its point directed downwards, is not unfrequently found in front of the internal condylar ridge, the *supracondylar process*. From its extremity, a fibrous band, giving origin to the pronator radii teres muscle, passes to the internal condyle, and through the arch thus formed passes the median nerve, accompanied frequently by the brachial artery, or by a large branch rising from it. This process represents a portion of the bone enclosing a foramen in carnivorous animals. (See Struthers, Edin. Med. Journ., 1848; Gruber, "Canalis supracondyloideus humeri," Mem. de l'Acad. Imp. de St. Petersburg, 1859, p. 57.) The thin plate between the olecranon and coronoid fossæ is sometimes perforated (*supratrochlear foramen*).

## THE ULNA.

The **ulna** is the internal of the two bones of the forearm. It is longer than the radius by the extent of the olecranon process. It is inclined downwards and outwards from the humerus in such a direction that a straight line passing from the great tuberosity of the humerus downwards through the capitellum would touch the lower end of the ulna.

The ulna articulates with the humerus and the radius: in the natural skeleton it is not in contact with the carpal bones, being excluded from the wrist-joint by an interarticular fibro-cartilage.

The *superior extremity* is of large size, and presents for articulation with the humerus a large articular surface, the *great sigmoid cavity*, which looks forwards and is bounded in its posterior and upper part by the olecranon, a thick process continued upwards from the shaft, and in its lower part by the coronoid process, which projects forwards. The great sigmoid cavity is concave from above downwards, and is convex from side to side, being traversed by a vertical ridge. The part external to this ridge is broad and convex above, while the part internal to the ridge is broad and concave below: a slight constriction, and sometimes a groove of division, occurs across the middle of the cavity. Continuous with the great is the *small sigmoid cavity*, a small articular surface on the outer side of the base of the coronoid process, concave from before backwards, and articulating with the cylindrical part of the head of the radius. Superiorly the *olecranon* is broad and uneven, terminating in front in an acute process or beak, which overhangs the great sigmoid cavity, and which in extension of the elbow passes into the olecranon fossa of the humerus, and behind in a rectangular prominence or *tuberosity*, which forms the point of the elbow, and gives attachment to the triceps extensor muscle. The posterior surface of the olecranon is subcutaneous and continuous with the posterior margin of the shaft of the ulna. The extremity of the *coronoid process* is sharp and prominent, and is received during flexion into the coronoid fossa of the humerus: its superior surface forms part of the surface of the great sigmoid cavity: the inferior surface rises gradually from the anterior surface of the bone, and is covered by a large triangular roughness which gives insertion to the brachialis anticus muscle.

The *body* or *shaft* in the upper three-fourths of its extent is three-sided, and presents a slight curve with the convexity backwards, but near the lower extremity it is slender, and more cylindrical. The *anterior surface* is grooved in the upper two-thirds, where the flexor profundus digitorum muscle takes origin, and in its lower end has an oblique line limiting the attachment of the pronator quadratus. Above the middle is a foramen for the medullary artery, directed upwards. The *internal surface* is smooth and convex; in the upper two-thirds giving attachment to the flexor profundus muscle, in the lower third subcutaneous. The *posterior surface*, more uneven, looks outwards and backwards; an oblique ridge descending from the hinder end of the small sigmoid cavity, limits a triangular area, which extends over the outer side of the olecranon and gives attachment to the anconeus muscle; below this a longitudinal line divides the surface into an inner portion, smooth, and covered by the extensor carpi ulnaris, and an outer part, more irregular, and impressed by the extensor muscles of the thumb and index fingers; in front of the surface for the anconeus, and immediately below the small sigmoid cavity, is a triangular excavated surface occupied by the origin of the supinator brevis muscle. Of the three borders, the *anterior* is thick and rounded; the *posterior* is sinuously curved, smooth, and prominent in the middle third; the *external* is sharp, and gives attachment to the interosseous ligament.

Fig. 71.

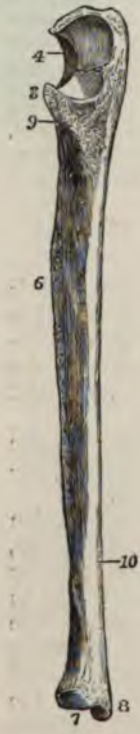


Fig. 72.

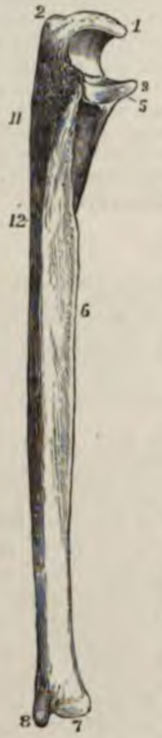


Fig. 71.—Right ulna from before.
Fig. 72.—Right ulna from behind. (A.T.) ½

1, point or beak of the olecranon; 2, tuberosity of the olecranon; 3, end of the coronoid process; 4, great sigmoid cavity; 5, lesser sigmoid cavity, and below it the surface for the supinator brevis muscle; 6, external or interosseous border; 7, lower extremity or head; 8, styloid process; 9, rough surface of insertion of the brachialis anticus muscle; below 10, the oblique line marking the attachment of the pronator quadratus muscle; 11, triangular surface for the anconeus muscle; 12, inner part of the posterior surface, to the right of which the depressions for the extensor muscles of the thumb occupy the posterior surface.

The *inferior extremity* presents a rounded head, from the inner and back part of which a short cylindrical eminence, the *styloid process*, projects downwards, giving attachment to the internal lateral ligament of the wrist-joint. The *head* bears two articular surfaces, an inferior, kidney-shaped and flattened, upon which the triangular fibro-cartilage of the wrist plays; and a lateral, narrow and convex, which is received into the sigmoid cavity of the radius. The head and the styloid process are separated posteriorly by a groove, which is traversed by the tendon of the extensor carpi ulnaris; and inferiorly by a depression, into which the triangular fibro-cartilage is inserted.

The ulna is placed in its whole length under the skin at the back of the forearm. The subcutaneous tract comprises the triangular surface on the back of the olecranon, the posterior border of the shaft, which lies at the bottom of the longitudinal groove between the flexor and extensor muscles, and, in the lower third, a narrow strip of the internal surface leading down to the styloid process; the latter projects at the inner and posterior part of the wrist.

### THE RADIUS.*

The **radius** is the external of the two bones of the forearm, and extends from the humerus to the carpus. It articulates with the humerus, the ulna, the scaphoid, and the semilunar bones.

The *superior extremity*, or *head*, is disc-shaped, with a smooth vertical margin. It presents on its summit a depression, which articulates with the capitellum of the humerus, and is surrounded by a convex part, broadest internally where it glides upon the groove internal to the capitellum. The smooth, short, cylindrical surface of the vertical margin, likewise broadest internally, rotates in the small sigmoid cavity of the ulna, and within the orbicular ligament. The head is supported on a constricted portion, named the *neck*.

The *shaft* or *body* is slightly curved, with the convexity directed outwards and backwards. On its internal aspect superiorly, where it is continuous with the neck, is the *bicipital tuberosity*, to the posterior rough portion of which is attached the tendon of the biceps muscle. Below the bicipital tuberosity the shaft presents three surfaces, of which the external is only indistinctly marked off from the others by smooth, rounded *anterior* and *posterior borders*, while the anterior and posterior surfaces are separated by a sharp, prominent *internal border*, which gives attachment to the interosseous membrane. The *external surface* is convex transversely as well as longitudinally; it is marked near the middle by a rough impression about one inch and a half long, which gives insertion to the pronator radii teres. The *anterior surface* is limited above by the prominent *oblique line* of the radius, running from the lower part of the tubercle downwards and outwards to form the anterior border; below this it is grooved longitudinally for the flexor longus pollicis, and at the lower end it is expanded, and presents a flat impression for the insertion of the pronator quadratus: above the middle is the foramen for the medullary artery, directed upwards into the bone. The *posterior surface* presents slight oblique impressions of the extensor muscles of the thumb.

The *lower extremity* of the radius, broad and thick, presents inferiorly a large surface, which articulates with the carpus, and internally a small one, which articulates with the ulna. The carpal articular surface, slightly concave, is divided by a line into a quadrilateral internal part, which articulates with the semilunar bone, and a triangular external part, which articulates with the scaphoid bone. The ulnar articular surface is placed at a right angle with the inferior surface; it is concave from before backwards, forming the *sigmoid cavity*, which plays over the rounded lower end of the ulna. At the outer part of the inferior surface the *styloid process*, projects downward, stout and pyramidal, giving attachment to the external lateral ligament of the wrist-joint, while the anterior and posterior margins are likewise rough and prominent for other ligaments. On its external and posterior aspects the inferior extremity of the radius is marked by grooves, which transmit the extensor tendons. Thus, on the external border, is a flat groove directed downwards and forwards, which lodges the extensor ossis metacarpi and extensor primi internodii pollicis; and on the posterior surface are three grooves, the middle one of which, oblique and narrow, and with prominent borders, lodges the extensor secundi internodii pollicis; while of the two others, which are broad and shallow, the external, subdivided by a slight mark, gives passage to the extensor carpi radialis longior and brevior, and the internal transmits the extensor communis digitorum and extensor indicis. Immediately above the first-mentioned groove on the outer side is a triangular rough mark, into which the tendon of the supinator longus is inserted.

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* In anatomical description the forearm is supposed to be placed in supination, with the thumb directed outwards and the palm of the hand looking forwards.

Fig. 73.

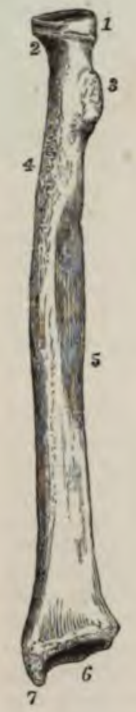


Fig. 74.

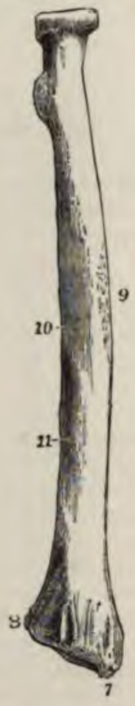


Fig. 73.—Right radius from before.
Fig. 74.—Right radius from behind. (A.T.) ½

1, head, showing the hollow above for the humerus, and the vertical surface surrounding it for the ulnar articulation; 2, neck; 3, tubercle; 4, is opposite to the oblique line; 5, interosseous ridge; the shaded part near 5 marks the slight hollow in which the flexor longus pollicis muscle lies; 6, carpal articular surface; 7, styloid process; 8, sigmoid cavity of the radius; 9, mark of the attachment of the pronator radii teres; 10 and 11, oblique impressions of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis; between 7 and 8, grooves for the tendons of the extensor muscles.

The radius is for the most part deeply placed. The head and shaft are entirely covered by muscles; at the lower end the styloid process comes to the surface between the tendons of the extensor muscles of the thumb, and forms a projection on the outer side of the wrist, lower down than the styloid process of the ulna.

### THE CARPUS.

The **carpus** is composed of eight short bones, which are disposed in two rows, four in each. Enumerated from the radial to the ulnar side, the bones which constitute the first or superior row are named *scaphoid*, *semilunar*, *pyramidal*, and *pisiform*; those of the second or inferior row, are the *trapezium*, *trapezoid*, *os magnum*, and *unciform*.

The dorsal surface of the carpus is convex, the palmar is concave from side to side, the concavity being bounded by four prominences, one at the outer and one at the inner extremity of each row. The anterior annular ligament is stretched across between these prominences, so as to form a canal for the transmission of the flexor tendons.

The superior surfaces of the scaphoid, semilunar, and pyramidal bones form, when in apposition, a continuous convexity which corresponds with the concavity presented by the radius and the triangular fibro-cartilage, while the pisiform bone is attached in front of the pyramidal, with which alone it articulates. The line of articulation between the superior and inferior rows is concavo-convex from side to side, the trapezium, trapezoid and os magnum bounding a cavity which lodges the external part of the scaphoid, and the os magnum and unciform rising up in a convexity, which is received into a hollow formed by the scaphoid, semilunar, and pyramidal bones.

Fig. 75.

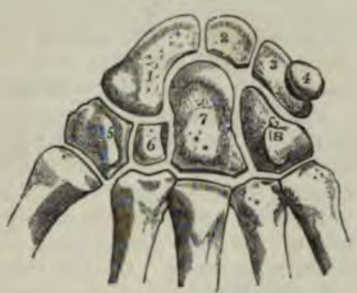


Fig. 75.—SEMI-DIAGRAMMATIC VIEW OF THE RIGHT CARPUS AND PART OF THE METACARPAL BONES, FROM BEFORE, THE CARPAL BONES BEING SLIGHTLY SEPARATED TO SHOW THE MODE OF THEIR CONNECTION WITH EACH OTHER. (A.T.) $\frac{2}{3}$

1, scaphoid bone ; 2, semilunar ; 3, pyramidal ; 4, pisiform ; 5, trapezium, the figure is placed upon the ridge, to the inside of which is the groove for the tendon of flexor carpi radialis ; 6, trapezoid ; 7, os magnum ; 8, unciform, the figure is placed on the unciform process. The articulation of the os magnum with the fourth metacarpal bone is represented somewhat too large.

The **scaphoid** bone, the largest and most external of the first row, lies with its long axis directed outwards and downwards. It has a concave surface, which looks downwards and inwards, and articulates with the os magnum ; on the opposite side are two convex articular surfaces, an upper for the radius. and a lower for the trapezium and trapezoid bones of the second row ; these approach so near to one another behind, that the dorsal surface is reduced to a narrow grooved transverse strip, to which the posterior ligaments of the wrist are attached. At the inner extremity is a small crescentic surface for articulation with the semilunar bone ; while the outer end is produced into a stout conical *tubercle*, which projects forwards and gives attachment to the annular ligament. The scaphoid articulates with five bones, viz., the radius, the semilunar, trapezium, trapezoid, and os magnum.

The **semilunar** bone, irregularly cubic, is characterized by the deep concavity from before backwards of its inferior surface, which rests on the head of the os magnum, and commonly also by a bevelled edge slightly on the unciform bone. Its external surface is crescentic and vertical, and articulates with the scaphoid bone ; its internal surface looks downwards and inwards, is much deeper and narrower than the external, and articulates with the pyramidal. The convex superior surface, which articulates with the radius, extends like that of the scaphoid, farther backwards than forwards, and hence the anterior free surface is deeper than the posterior. The semilunar articulates with five bones, viz., the radius, scaphoid, pyramidal, os magnum, and unciform.

The **pyramidal** or *cuneiform* bone is situated with its blunted apex directed downwards and inwards ; the base has the shape of a half-oval, and articulates with the semilunar bone. There are three surfaces; the inferior, concavo-convex from without inwards, articulates with the unciform bone; the anterior is distinguished by having a smooth circular facet on its inner half for articulation with the pisiform bone; and the supero-posterior, presents at the base a small articular facet entering the wrist-joint, but is for the most part rough for the attachment of ligaments. The pyramidal articulates with three bones, viz., the semilunar, pisiform, and unciform.

The **pisiform** bone lies on a plane anterior to the other bones of the carpus. Posteriorly it possesses an articular surface, which rests on the pyramidal bone. The mass of the bone is so inclined from this surface downwards and outwards, that the pisiform bone of one hand is distinguishable from that of the other.

The **trapezium** is the most external of the second row of carpal bones. It presents a rhombic form when seen in its dorsal or palmar aspect, but with the lower angle much produced and truncated. Its anterior surface is marked by a vertical groove traversed by the tendon of the flexor carpi radialis muscle, and external to the groove by a ridge, one of the four prominences which give attachment to the anterior annular ligament. Of the internal sides of the rhomb, the superior articulates with the scaphoid and the inferior with the trapezoid; while a small facet on the prominent lower angle is for the second metacarpal bone. Of the external sides the superior is free, and the inferior presents a smooth surface, convex from behind forwards, and concave from without inwards, which articulates with the metacarpal bone of the thumb, and is separated by a small interval from the surface for the second metacarpal bone. The trapezium articulates with four bones, viz., the scaphoid, trapezoid, and first and second metacarpals.

The **trapezoid** bone is considerably smaller than the trapezium. Its longest diameter is from before backwards. Its posterior free surface is much larger than the anterior. The external inferior angle of the anterior surface is distinguished by being prolonged a little backwards between the articular surfaces for the trapezium and second metacarpal bone. The superior surface articulates with the scaphoid; the external with the trapezium; the internal with the os magnum; and the inferior by a large surface convex from side to side with the second metacarpal bone. The trapezoid articulates with four bones, viz., the scaphoid, trapezium, os magnum, and second metacarpal bone.

The **os magnum** is the largest of the carpal bones. In form it is elongated vertically, rectangular inferiorly, rounded superiorly. The upper extremity or *head* articulates above with the semilunar bone by a convex surface, extending further down behind than in front, and prolonged on the outer side for the scaphoid. A *neck* is formed beneath by depressions on the anterior and posterior surfaces. The anterior surface of the bone is much narrower than the posterior. The posterior surface projects downwards at its internal inferior angle. On the outer side beneath the surface for the scaphoid is a short surface for the trapezoid bone; and on the inner side is a vertically elongated surface which articulates with the unciform bone. Inferiorly this bone articulates by three distinct surfaces, of which the middle is much the largest, with the second, third, and fourth metacarpal bones. The os magnum articulates with seven bones, viz., the scaphoid, semilunar, trapezoid, unciform, and second, third, and fourth metacarpal bones.

The **unciform** bone is readily distinguished by the large hook-like process projecting forwards and curved slightly outwards on its anterior surface. Seen from the front or behind, it has a triangular form. Its external surface is vertical, and articulates with the os magnum; its inferior surface is divided into two facets which articulate with the fourth and fifth metacarpal bones; its superior surface, meeting the pyramidal, is concavo-convex, inclines upwards and outwards towards the head of the os magnum, and is separated internally by a rough border from the inferior surface. The unciform articulates with five bones, viz., the os magnum, semilunar, pyramidal, and fourth and fifth metacarpal bones.

### THE METACARPUS.

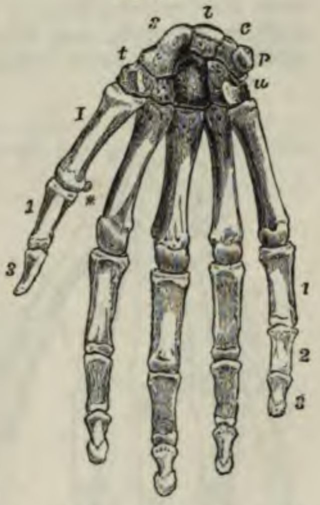
The **metacarpus**, the part of the hand which supports the fingers, consists of five long bones, diverging slightly from each other, and which are numbered from without inwards.

Fig. 76.—THE RIGHT HAND FROM BEFORE. (A. T.) ½

*s*, scaphoid; *l*, semilunar; *c*, pyramidal; *p*, pisiform; *t*, trapezium; next to it the trapezoid, and then the os magnum, both not lettered; *u*, unciform.

I to V, the metacarpal bones; 1, 3, first and second phalanges of the thumb; 1, 2, 3, the first, second, and third phalanges of the little finger, and similarly for the other three fingers, not marked; * one of the sesamoid bones of the thumb seen sideways.

Fig. 76.



The metacarpal bones are placed in a segment of an arch transversely, and being at the same time slightly curved longitudinally, they present a concavity directed forwards. They are terminated at their carpal extremities by expanded bases of different forms, and at the digital ends by large rounded heads. The first metacarpal bone is broader and shorter than the others. The second is the longest of all, the third, fourth, and fifth decrease regularly in length, according to their position from without inwards.

The *shaft* of the first metacarpal bone is somewhat compressed from before backwards; the dorsal surface is slightly convex; on the palmar aspect is a rounded longitudinal ridge, placed nearer to the inner than the outer border. The shafts of the others are three-sided, presenting a surface towards the back of the hand, and towards the palm a smooth margin between the two lateral surfaces. They are most slender immediately beyond the carpal extremity, and become gradually thicker towards the head. On the dorsal aspect of each is a triangular surface, bounded by lines which, proceeding from the sides of the head, pass upwards and converge in the second, third, and fourth metacarpal bones opposite the middle of the carpal extremity, and in the fifth towards its inner side.

The *heads* articulate with the proximal phalanges Their smooth, rounded surfaces are broader, and extend farther, on the palmar than on the dorsal aspect of the bones ; and on each side is a tubercle with a hollow below it for the attachment of the lateral ligament.

The *carpal extremity* presents distinctive peculiarities in each metacarpal bone. That of the first has a saddle-shaped articular surface, concave from before backwards, and convex from side to side, which articulates with the trapezium ; and externally a slight prominence, to which the extensor ossis metacarpi pollicis is attached. The second is notched to receive the trapezoid bone : on the radial side is a small facet for the trapezium ; the more prominent ulnar lip articulates superiorly by a narrow surface with the os magnum, and internally with the third metacarpal bone. The third bone articulates superiorly with the os magnum, and on the sides with the contiguous metacarpal bones ; at its posterior and outer angle it forms a projection upwards, *styloid process*. The fourth articulates principally with the unciform bone above, but also by a small facet at the posterior and outer corner with the os magnum ; on its radial side are two small surfaces, and on the ulnar side one, for articulation with the adjacent metacarpal bones. The fifth articulates superiorly with the unciform bone by means of a saddle-shaped surface directed slightly outwards, and externally with the fourth metacarpal bone, while on its ulnar side it presents a rough and prominent tuberosity.

Fig. 77.

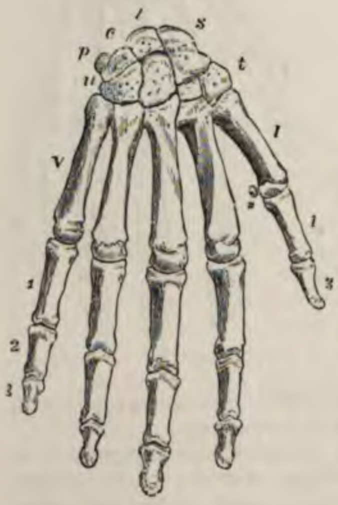


Fig. 77.—RIGHT HAND SEEN FROM BEHIND. (A. T.) $\frac{1}{3}$

The indications are the same as in the preceding figure.

### THE DIGITAL PHALANGES.

The **phalanges** (*internodia*) are fourteen in number ; three for each finger, but only two for the thumb.

Those of the *first row* are slightly curved like the metacarpal bones. Their dorsal surfaces are smooth and transversely convex ; the palmar are flat from side to side, and bounded by rough margins, which give insertion to the fibrous sheaths of the flexor tendons. Their proximal extremities are thick, and articulate each by a transversely oval concave surface with the corresponding metacarpal bone. Their distal extremities, smaller and more compressed antero-posteriorly, are divided by a shallow groove into two condyles.

Those of the *middle row* are four in number. Smaller than those of the preceding set, they resemble them in form, with this difference, that their proximal extremities present, on the articular surface, a slight middle elevation and two lateral depressions, adapted to articulate with the condyles of the first phalanges.

The *terminal* or *ungual* phalanges, five in number, have proximal extremities similar to those of the middle row, but with a depression in front, where the flexor tendon is inserted. They taper towards their somewhat flattened and expanded free extremities, which are rough and raised round the margins and upon the palmar aspect in the *ungual process*.

SESAMOID BONES.—A pair of sesamoid bones is placed in the palmar wall of the metacarpo-phalangeal articulation of the thumb; and similar nodules, single or double, are sometimes found in the corresponding joint of one or more of the other fingers, most frequently of the index and little fingers.

### OSSIFICATION OF THE BONES OF THE UPPER LIMB.

With the exception of the clavicle, all the bones of the upper limb begin to ossify in cartilage.

The **clavicle** begins to ossify before any other bone in the body. Its ossification commences before the deposition of cartilage in connection with it, but afterwards progresses in cartilage as well as in fibrous substance. It is formed from one principal centre, appearing about the 6th week, to which is added an epiphysis at the sternal end. The epiphysis appears from the 18th to the 20th year and is united to the shaft about the 25th year.

Fig. 78.

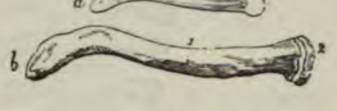


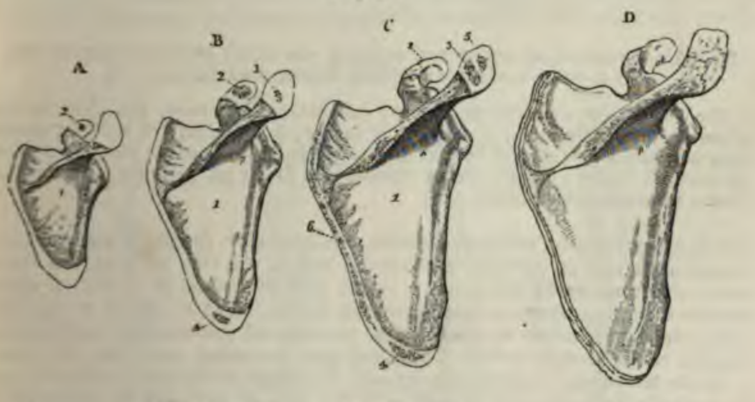
Fig. 78.—OSSIFICATION OF THE CLAVICLE (R. Quain).

*a*, the clavicle of a fœtus at birth, osseous in the shaft, 1, and cartilaginous at both ends.

*b*, clavicle of a man of about twenty-three years of age; the shaft, 1, fully ossified to the acromial end; the sternal epiphysis, 2, is represented rather thicker than natural.

The **scapula** is ossified from two primary centres, one for the body, the scapula

Fig. 79.



1 year. 15 or 16 years. 17 or 18 years. 22 years.

Fig. 79.—OSSIFICATION OF THE SCAPULA (R. Quain).

1, scapula proper, including the body and spine; 2, coracoid ossification; 3, 5, nuclei of acromion; 4, epiphysis at the lower angle; 6, epiphysis on vertebral border.

In A, ossification has commenced in the coracoid process. In B the coracoid process (represented as too little ossified in the figure) is now partially united at its base, and centres have appeared in the acromion and at the lower angle. In C, a second point has appeared in the acromion, and a long epiphysis on the vertebral border. In D, the acromion and the epiphysis of the vertebral border are still separate.

proper, the other for the coracoid process, which represents the independent and often largely developed coracoid bone of the monotremata and lower vertebrates. The nucleus for the body appears near the head about the 7th or 8th week. This centre forms a triangular plate of bone near the upper margin of which, about the 3rd month, the spine appears as a slight ridge. At birth the coracoid and acromion processes, the base and inferior angle, the edges of the spine and of the glenoid cavity are cartilaginous. The nucleus of the coracoid process appears in the first year, and this forms also a small portion of the glenoid cavity at the upper end. The coracoid process joins the body about the age of puberty, and at this time epiphyses make their appearance. In the acromion two, sometimes three, nuclei appear between the 14th and 16th years; they soon coalesce and the resulting epiphysis is united to the spine from the 22nd to the 25th year. The cartilage of the base, which it may be noticed corresponds to a more largely developed permanent cartilage or bone, *suprascapular*, found in many animals, becomes the seat of ossification about the 16th to the 18th year, by the appearance of a nucleus at the inferior angle, and thereafter of a line of osseous deposit extending upwards throughout its length. A thin lamina is also added along the upper surface of the coracoid process, and occasionally another at the margin of the glenoid cavity. These epiphyses are united about the 25th year.

Fig. 80.

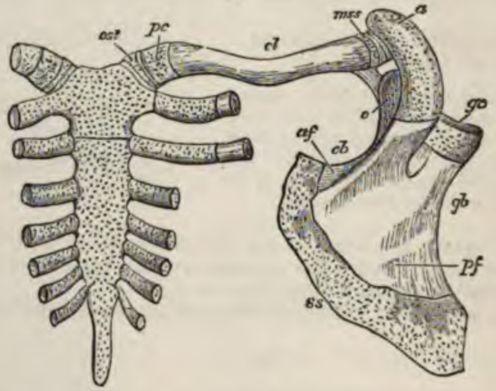


Fig. 80.—Posterior aspect of the sternum and right shoulder girdle from a fœtus of about four months (Flower after Parker). 1½

The dotted parts are cartilaginous; *ost*, omosternum, afterwards becoming the inter-articular fibro-cartilage; *pc*, precoracoid of Parker; *a*, acromion; *cl*, shaft of clavicle; *mss*, mesoscapular segment of Parker; *c*, coracoid; *gc*, glenoid cavity; *gb*, glenoid border; *cb*, coracoid border; *af*, anterior or supraspinous fossa; *pf*, posterior or infraspinous fossa; *ss*, suprascapular border.

In the **humerus** a nucleus appears near the middle of the shaft in the 8th week. It gradually extends, until at birth only the ends of the bone are cartilaginous. About the beginning of the 2nd year the nucleus of the head appears, and during the 3rd year that for the great tuberosity. The lesser tuberosity is either ossified from a distinct nucleus which appears in the 5th year, or by extension of ossification from the great tuberosity. These nuclei unite together about the 5th year to form an epiphysis, which is not united to the shaft till the 20th year. In the cartilage of the lower end of the bone four separate nuclei are seen, the first appearing in the capitellum in the 3rd year. The nucleus of the internal condyle appears in the 5th year, that of the trochlea in the 11th or 12th year, and that of the external condyle in the 13th or 14th year. The nucleus of the internal condyle forms a distinct epiphysis which unites with the shaft in the 18th year;

the other three nuclei coalesce to form an epiphysis, which is united to the shaft in the 16th or 17th year.

Fig. 81.

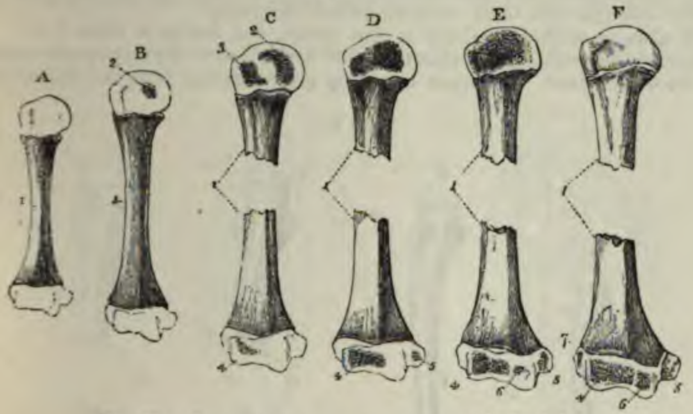


Fig. 81.—Ossification of the humerus (R. Quain).

A, from a full grown fœtus; B, at two years; C, in the third year; D, at the beginning of the fifth year; E, at about the twelfth year; F, at the age of puberty.

1, the primary centre for the shaft; 2, nucleus for the head; 3, that for the great tuberosity; 4, for the capitellum and adjacent part of the trochlea; 5, for the internal condyle; 6, for the inner part of the trochlea; 7, for the external condyle. In this and the following figures the more advanced bones are shown on a smaller scale than the earlier ones.

The **radius** is developed from a nucleus, which appears in the middle of the shaft in the 8th week, and from an epiphysial nucleus in each extremity which

Fig. 82.

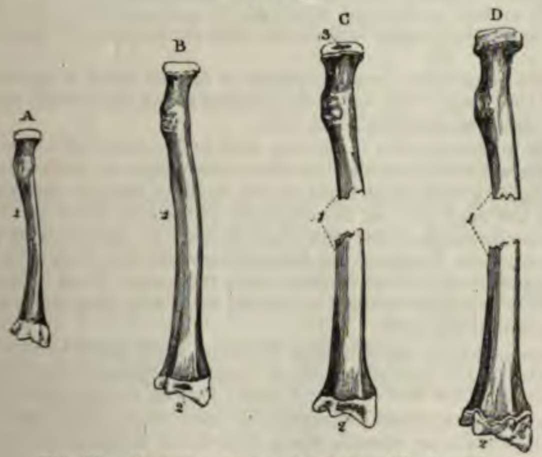


Fig. 82.—Ossification of the radius (R. Quain).

A, the radius of a full-grown fœtus; B, at about two years of age; C, at five years; D, at about eighteen years.

1, shaft; 2, ossific point of the lower epiphysis; 3, that of the upper end. In D, the upper epiphysis is united to the shaft, while *the lower is still* separate.

only appears some time after birth. The nucleus in the carpal extremity appears at the end of the 2nd year, while that of the head is not seen till the 5th or 6th year. The superior epiphysis and shaft unite about the 17th or 18th year; the inferior epiphysis and shaft unite about the 20th year.

The **ulna** is ossified similarly to the radius, but begins a little later. The nucleus of the shaft appears about the 8th week, that of the carpal extremity in the 4th or 5th year. The upper extremity grows mainly from the shaft, but at the end of the olecranon a small epiphysis is formed from a nucleus which appears in the 10th year. This epiphysis is united to the shaft about the 17th year; the inferior epiphysis about the 20th year.

Fig. 83.

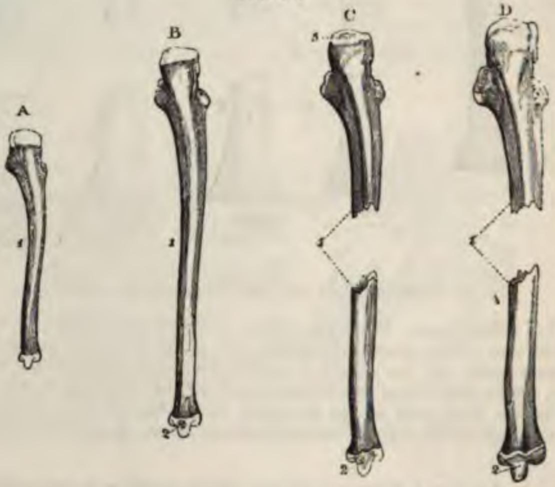


Fig. 83.—Ossification of the ulna (R. Quain).

A, the ulna at birth; B, at the end of the fourth year; C, of a boy of about twelve years of age; D, of a male of about nineteen or twenty years.

1, shaft; 2, nucleus of the lower epiphysis; 3, nucleus of the upper epiphysis. In D, the upper epiphysis is united to the shaft, while the lower is still separate.

From what is stated above it appears that in the bones of the arm and forearm the epiphyses which meet at the elbow-joint begin to ossify later, and unite with their shafts earlier, than those at the opposite ends of the bones, while in the bones of the thigh and leg the epiphyses at the knee-joint are the soonest to ossify and the latest to unite with their shafts. In the bones of the arm and forearm the nutrient foramina are directed towards the elbow; in those of the thigh and leg they are directed away from the knee. Thus in each bone the epiphysis of the extremity towards which the medullary foramen is directed is the first to be united to the shaft.

The **carpus** is entirely cartilaginous at birth. Each carpal bone is ossified from a single nucleus. The nucleus of the os magnum appears in the first year; that of the unciform in the first or second year; that of the pyramidal in the third year; those of the trapezium and semilunar bones in the fifth year; that of the scaphoid in the sixth or seventh year; that of the trapezoid in the seventh or eighth year; and that of the pisiform in the twelfth year.

The **metacarpal bones** and **phalanges** are usually formed each from a principal centre for the shaft and one epiphysis. The ossification of the shaft begins about the eighth or ninth week. In the four inner metacarpal bones the
is at the distal extremity, while in the metacarpal bone of the thumb
alanges it is placed at the proximal extremity. In many instances,

however, as was known to Albinus, and has been more fully shown by Allen Thomson (Jour. of Anat. 1869), there is also a distal epiphysis visible in the first metacarpal bone at the age of seven or eight years, and there are even traces of a proximal epiphysis in the second metacarpal. In the seal and some other

Fig. 84.

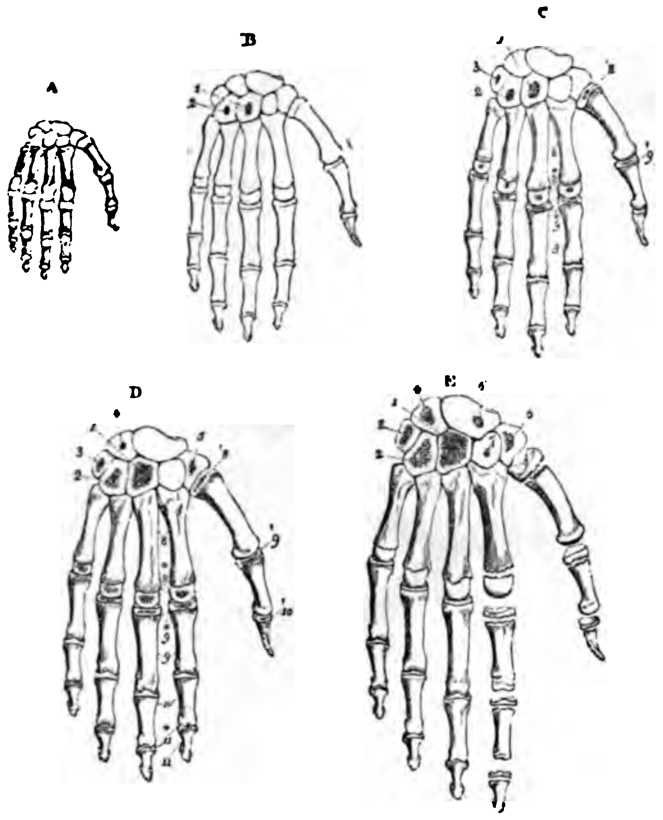


Fig. 84.—Ossification of the bones of the hand (R. Quain).

A, the condition at birth. The carpus is entirely cartilaginous. Each of the metacarpal bones and digital phalanges has its shaft ossified.

B, at the end of the first year; the os magnum and unciform have begun to ossify.

C, about the third year. Centres of ossification are seen in the pyramidal and in the proximal epiphysis of the first and the distal epiphyses of the other four metacarpal bones, and in the proximal epiphyses of the first row of phalanges.

D, at the fifth year. Centres have been formed in the trapezium and later in the semilunar bone, and in the epiphyses of the middle and distal phalanges: (the figure does not show them distinctly in the middle phalanges).

E, at about the ninth year. Centres have been formed in the scaphoid and trapezoid bones, and the more developed epiphyses of the metacarpal bones and phalanges are shown in the first and second digits separately.

1, os magnum; 2, unciform; 3, pyramidal; 4, semilunar; 5, trapezium; 6, scaphoid; 7, trapezoid; 8, metacarpal bones, the principal pieces; 8*, four metacarpal epiphyses; 8′, that of the thumb; 9, first phalanges; 9*, their epiphyses; 9′, that of the thumb; 10, second phalanges; 10′, epiphysis of terminal phalanx of thumb; 11, terminal phalanges of the fingers; 11*, their epiphyses.

animals there are always two epiphyses in these bones. The epiphyses begin to be ossified from the third to the fifth year, and are united to their respective shafts about the twentieth year. The terminal phalanges of the digits present the remarkable peculiarity that the ossification of their shafts commences at the distal extremity, instead of in the middle of their length, as is the case with the other phalanges and with the long bones generally (Schäfer and Dixey, Proc. Roy. Soc. xxx. 550, xxxi. 63).

## V.—THE PELVIS AND LOWER LIMB.

The divisions of the lower limb are the haunch or hip, thigh, leg, and foot. In the haunch is the hip-bone, which enters into the formation of the pelvis; in the thigh is the femur; in the leg the tibia and fibula; and at the knee a large sesamoid bone, the patella. The foot is composed of three parts, viz., the tarsus, metatarsus, and phalanges.

### THE HIP-BONE.

The **hip-bone**, *os coxæ*, or *innominate bone*, with its neighbour of the opposite side and the addition of the sacrum and coccyx, forms the pelvis; it transmits the weight of the body to the lower limb. It is constricted in the middle and expanded above and below, and is so curved that whilst the upper part is nearly vertical the lower part is directed inwards. On the external aspect of the constricted portion is the *acetabulum*, a cavity which articulates with the femur, and perforating the inferior expansion is a large opening, the *obturator foramen*. The superior wider part of the bone forms part of the abdominal wall: the inferior enters into the formation of the true pelvis. The hip-bone articulates with its fellow of the opposite side, with the sacrum, and with the femur.

Fig. 85.

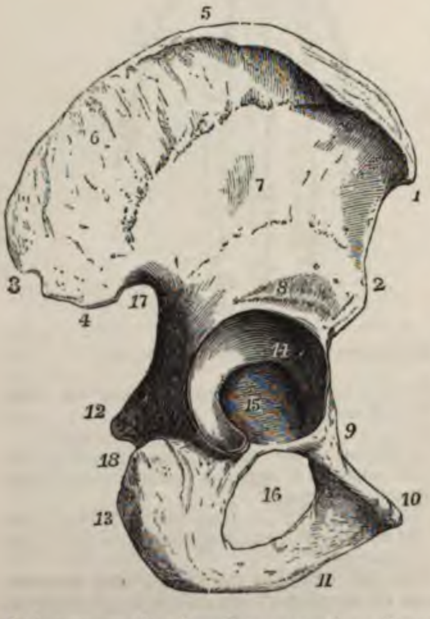


Fig. 85.—Right hip-bone, outer surface. (A. T.) $\frac{1}{3}$

1, anterior superior, 2, anterior inferior spine; 3, posterior superior, 4, posterior inferior spine; 5, crest of the ilium; 6, surface occupied by the gluteus medius muscle above the middle curved line; between 6 and 3 are seen the superior curved line and the rough surface for the gluteus maximus; 7, surface between the middle and inferior curved lines occupied by the gluteus minimus; 8, impression of the posterior tendon of the rectus femoris; 9, superior ramus of the pubis, and ilio-pectineal eminence; 10, crest and spine of the pubis; 11, place of meeting of the inferior ramus of the pubis with the ramus of the ischium; 12, spine, and 13, tuberosity of the ischium; 14, articular portion, 15, non-articular portion of the acetabulum; 16, thyroid or obturator foramen; 17, great, and 18, small sciatic notches.

In the description of this bone it is convenient to recognise as distinct the three parts of it which are separate in early life, viz., the *ilium*, *os pubis* and *ischium*. These three portions meet at the acetabulum, in the formation of which they all take part; and the os pubis and ischium also meet on the inner side of the obturator foramen.

The **ilium** constitutes the superior expanded portion of the bone, and forms a part of the acetabulum by its inferior extremity. Above the acetabulum it is limited anteriorly and posteriorly by margins which diverge at right angles one from the other, and superiorly by an arched thick border, the *crest of the ilium*. The *crest* is curved like the letter *ſ*, the fore part being concave inwards, the hinder part concave outwards; its surface is broadest in its anterior and posterior thirds; it is rough for the attachment of muscles, and on it may be distinguished an external and internal lip and an intermediate ridge. The anterior extremity of the crest forms a projection forwards called the *anterior superior spine of the ilium*, and, separated from it by a concave border, and placed immediately above the acetabulum, is another eminence called the *anterior inferior spine:* the projecting posterior extremity of the crest forms the *posterior superior spine*, and separated from it by a notch is the *posterior inferior spine*, below which the posterior border of the bone is hollowed out into the *great sciatic* (*ilio-sciatic*) *notch*. The external surface, or *dorsum* of the ilium, is traversed by three *curved lines*, which limit the areas of attachment of the gluteal muscles. The *superior curved line* leaves the iliac crest about one-fourth of its length from the posterior superior spine, and curves downwards and forwards towards the hinder part of the great sciatic notch: the *middle curved line* begins in front at the iliac crest, about one inch and a half from its anterior extremity, and arches backwards and downwards to the upper margin of the great sciatic notch: the *inferior curved line*, less strongly marked than the middle, commences at the anterior border, just above the anterior inferior spine, and is continued backwards nearly parallel to the margin of the acetabulum to the fore part of the great sciatic notch. Behind the superior line is a narrow semilunar surface, the upper portion of which is rough and gives attachment to the gluteus maximus muscle, while the lower part is smooth and free from muscular attachment. The sickle-shaped space between the iliac crest and superior curved line above and the inferior curved line below is occupied by the gluteus medius; and the surface between the middle and inferior curved lines gives origin to the gluteus minimus. On the lowest part of this surface, immediately above the margin of the acetabulum, is a rough elongated mark where the posterior head of the rectus femoris is attached.

The internal surface of the ilium is divided into two parts. The anterior of these (*iliac surface*) is the larger; it is smooth and concave, occupied by the iliacus muscle, and is known as the *iliac fossa*. The posterior part (*sacral surface*) is again subdivided, presenting from below upwards:—1, a smooth surface entering into the formation of the true pelvis, and continuous with the pelvic surfaces of the pubis and ischium, only a faint line indicating in the adult the place of union; this is separated from the iliac fossa by a smooth rounded border, the iliac portion of the *ilio-pectineal line:* 2, the uneven *auricular surface*, in the recent state covered with cartilage, for articulation with the sacrum, broad in front and extending on to the posterior inferior spine behind: 3, some deep impressions for the attachment of the sacro-iliac ligament; and 4, a less rough surface reaching up to the hinder portion of the iliac crest and giving origin to the lower parts of the erector and multifidus spinæ muscles.

Fig. 86.

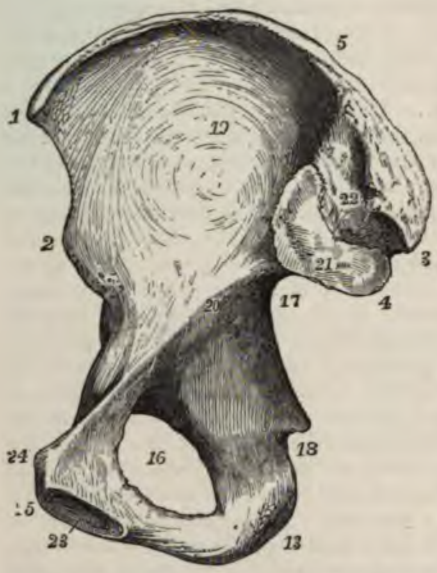


Fig. 86.—RIGHT HIP-BONE, INNER OR PELVIC SURFACE. (A. T.) ⅓

1, 2, 3, 4, 5, 16, 17, and 18, indicate the same parts as in the preceding figure; 19, iliac fossa; 20, ilio-pectineal line; 21, auricular surface; 22, deep impressions for the posterior sacro-iliac ligament, and behind these the surface for the erector and multifidus spinæ muscles; 23, oval surface of the symphysis pubis; 24, pubic spine; 25, angle of the pubis; between 24 and 25, the pubic crest; between 17 and 20, the pelvic surface of the ilium.

The **os pubis** forms the anterior wall of the pelvis, and bounds the obturator foramen in the upper half of its extent. At its outer and upper extremity it forms a part of the acetabulum; at its inner extremity it presents an elongated oval surface which forms the articulation with the bone of the opposite side, the junction being called the *symphysis of the pubis.* The part which passes downwards and outwards below the symphysis is called the *inferior* or *descending ramus*, the upper part is called the *superior* or *ascending ramus*, and the flat portion between the rami is the *body*. The deep or pelvic surface of the body is smooth; the anterior or femoral surface is roughened near the symphysis by the attachments of muscles. At the superior extremity of the symphysis is the *angle* of the pubis, and extending outwards from this on the superior border is the rough *crest*, terminating in the projecting *spine*. The inferior ramus is flattened: the superior ramus becomes prismatic, and increases in thickness as it passes upwards and outwards, and between its posterior and superior surfaces there is prolonged outwards from the spine a ridge which is the pubic portion of the *ilio-pectineal line*. The surface in front of this line is covered by the pectineus muscle; the inferior surface of the ramus presents a deep groove directed from behind forwards and inwards for the obturator vessels and nerve. On the superior surface above the acetabulum there is an elevation, the *ilio-pectineal eminence*, marking the place of junction of the pubis and ilium.

The **ischium** forms the posterior and inferior part of the hip-bone, and bounds the obturator foramen in the lower half of its extent. Superiorly it enters into the acetabulum, inferiorly it forms a thick projection, the *tuberosity*, and this part, diminishing in size, is continued forwards into the *ramus*. On its posterior border, behind the acetabulum, a sharp process, the *spine*, projecting with an inclination inwards, forms the inferior limit of the *great sciatic notch*, and is separated from the tuberosity by a short interval, the *small sciatic notch*, against the smooth margin of which glides the tendon of the obturator internus muscle. In front of this, on the external surface, a horizontal groove, occupied by the upper border of the obturator externus muscle, lies between the inferior margin of the acetabulum and the tuberosity. The tuberosity presents a rough pyriform surface continuous with the internal margin of the ramus, on the broader superior portion of which are two impressions, placed side by side, the outer for the semimembranosus, the inner for the conjoined origins of the biceps and semitendinosus, while the lower part is ridged and gives attachment to the adductor magnus muscle; the inner border is sharp and prominent where the great sacro-sciatic ligament is attached, and along the outer margin is a faint elongated impression marking the place of origin of the quadratus femoris muscle. The ramus of the ischium is flattened like the inferior ramus of the pubis, with which it is continuous on the inner side of the obturator foramen.

The *acetabulum*, or *cotyloid cavity*, is a cup-shaped hollow, looking outwards, downwards, and forwards, and surrounded in the greater part of its circumference by an elevated margin, which is most prominent at the posterior and upper part; while at the opposite side, close to the obturator foramen, it is deficient, forming the *cotyloid notch*. Its lateral and upper parts present a broad horseshoe-shaped smooth surface, which articulates with the head of the femur, and in the recent state is coated with cartilage, but the lower part of the cup and the region of the notch are depressed below the level of the articular surface, lodge a mass of fat and the interarticular ligament, and have no cartilaginous coating. Rather more than two-fifths of the acetabulum are formed from the ischium, less than two-fifths from the ilium, and the remainder from the pubis. The iliac portion of the articular surface is the largest, the pubic the smallest: the non-articular surface belongs chiefly to the ischium.

The *obturator* or *thyroid* foramen, also called *foramen ovale*, is internal and inferior to the acetabulum. In the male it is nearly oval, with the long diameter directed downwards and outwards; in the female it is more triangular, or narrowed at its lower part. In the recent state it is closed by a fibrous membrane, except in the neighbourhood of the groove in its upper margin.

The hip-bone varies greatly in thickness at different parts. The strongest portions are found along the lines of greatest pressure; these are, a very thick bar in the ilium between the auricular surface and the acetabulum, through which the weight of the body is transmitted to the thigh-bones, and a second formed by the ischium, ending in the tuberosity, which supports the body in the sitting posture. The ilium has also a thick rib running from the acetabulum to the most prominent portion of the iliac crest, while the bone between this and the auricular surface, corresponding to the deepest part of the iliac fossa, is very thin. The floor of the non-articular portion of the acetabulum is also a thin plate of bone, and this, as well as the thin part of the ilium, is occasionally perforated.

The crest of the ilium is subcutaneous, and forms the boundary between the abdomen and the region of the hip. In front the pubic spine is to be felt through the integuments, and lower down the inner margin of the united rami of the ischium and pubis can be followed to the ischial tuberosity, dividing the perineum from the thigh. The remainder of the bone is thickly covered by muscles.

### THE PELVIS.

The hip-bones with the sacrum and coccyx form the pelvis.

This part of the skeleton may be considered as divided into two parts by a plane passing through the sacral promontory, the ilio-pectineal lines, and the upper border of the symphysis pubis. The circle thus completed constitutes the *brim* or *inlet* of the lower or *true pelvis ;* the space above it, between the iliac fossæ, belongs really to the abdomen, but has been called the upper or *false pelvis.* The inferior circumference, or *outlet* of the pelvis, presents three large bony eminences, the coccyx and the tuberosities of the ischia. Between the tuberosities of the ischia in front is the *subpubic arch,* which bounds an angular space extending forwards to the symphysis, and is formed by the inferior rami of the pubes and the rami of the ischia. The interval between the sacrum and coccyx and the ischium on each side is bridged over in the recent state by the sacro-sciatic ligaments, which therefore assist in bounding the outlet of the pelvis.

Fig. 87.

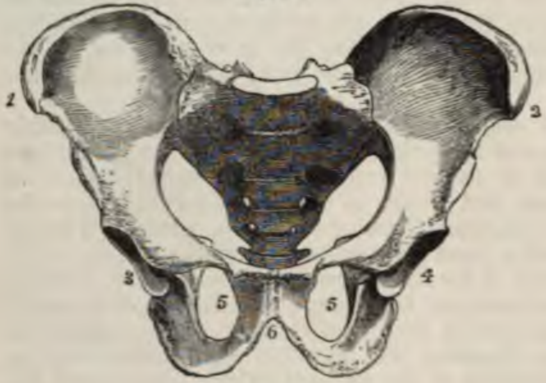


Fig. 87.

Adult male pelvis seen from before, in the erect attitude of the body. (A. T.) $\frac{1}{4}$

1, 2, anterior extremities of the iliac crests in front of the greatest transverse diameter of the false pelvis ; 3, 4, acetabula ; 5, 5, obturator foramina ; 6, subpubic angle or arch.

Fig. 88.

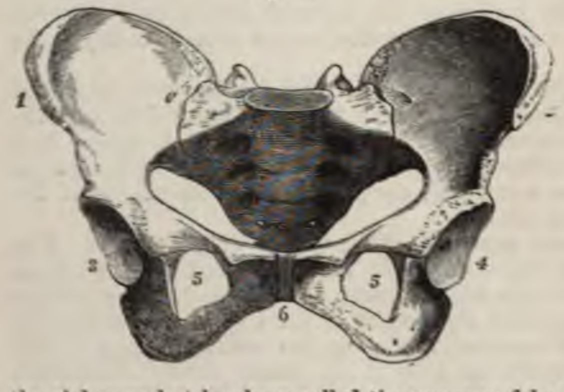


Fig. 88.

Adult female pelvis. (A. T.) $\frac{1}{4}$

Similarly placed with that shown in the preceding figure, and illustrating by comparison with it, the principal differences between the male and female pelvis. The numbers indicate the same parts as in the preceding figure.

**Position of the pelvis.**—In the erect attitude of the body, the pelvis is so inclined that the plane of the brim of the true pelvis forms an angle with the horizontal, which varies in different individuals from 60° to 65°. The base of the sacrum was found by Nägele in a large number of well-formed female bodies to be about $3\frac{3}{4}$ inches above the upper margin of the symphysis pubis; the level of the top of the coccyx he found varying from 22 lines above the apex of the pubic arch to 9 lines below the same point, and on an average to be 7 or 8 lines above it (Nägele, "Das weibliche Becken," &c., Carlsruhe, 1825; Wood, article "Pelvis" in the Cyclopædia of Anatomy and Physiology). The pelvic surface of the sacrum, near its base, looks much more downwards than forwards, hence the sacrum appears at first sight to occupy the position of the keystone of an arch; but being in reality broader at its pelvic than on its dorsal aspect, it is a keystone inverted, or having its broad end lowest, and is supported in its place chiefly by ligaments, but also to a slight extent by the inward projection of the anterior margin of the iliac articular surface. The line of pressure of the weight of the body on the sacrum is directed downwards towards the symphysis pubis, and the resistance of the head of the thigh-bone on each side is directed upwards and inwards.

Figs. 89 & 90.

SKETCHES OF THE MALE AND FEMALE PELVIS AS SEEN FROM ABOVE AND IN FRONT. (A.T.) $\frac{1}{4}$

In fig. 90 of the female pelvis the lines are shown in which the dimensions of the pelvis are usually measured at the brim.

*a*, *p*, antero-posterior or conjugate diameter; *t*, *r*, transverse or widest diameter; *o*, *b*, *o*, *b*, oblique diameters.

In the original specimens, which were selected as giving the full average dimensions, the following were the measurements in inches:—

Antero-posterior diameter — female, $4\frac{1}{3}$; male, 4. Transverse diameter—female, $5\frac{1}{4}$; male, $4\frac{1}{2}$. Oblique diameter — female, 5; male, $4\frac{1}{4}$.

Fig. 89.

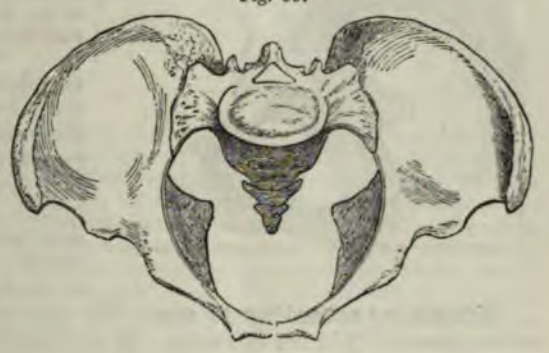
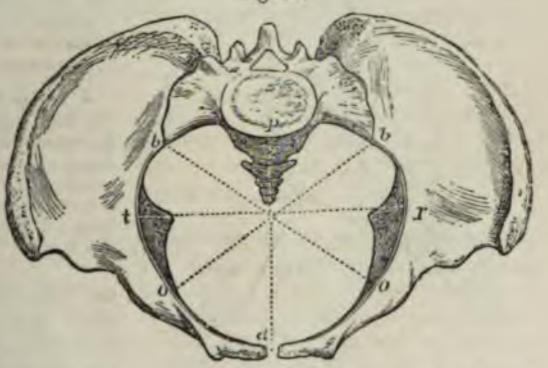


Fig. 90.



The *axis of the pelvis* is the name given to a line drawn at right angles to the planes of the brim, cavity and outlet, through their central points. The posterior wall, formed by the sacrum and coccyx, being about five inches long and concave, while the anterior wall at the symphysis pubis is only one and a half or two inches long, the axis is curved; it is directed at the inlet upwards and forwards towards the umbilicus, and at the outlet downwards and a little backwards or forwards according to the level of the coccyx.

Fig. 91.

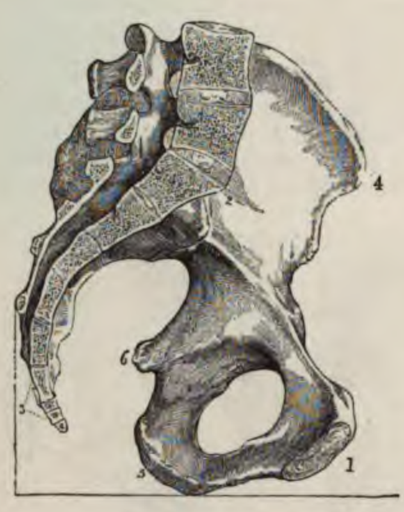


Fig. 91.—VERTICAL MEDIAN SECTION OF A FEMALE PELVIS (reduced from Nägele's figure). ⅓

1, symphysis pubis; 2, promontory of the sacrum; 3, coccygeal bones; 4, anterior superior spine of ilium; 5, tuberosity of ischium; 6, spine of ischium (the obturator foramen is not represented so pointed below as it generally is in females). The vertical and horizontal lines in the lower part of the figure will assist the eye in judging of the degree of inclination of the pelvis, as illustrated by the next figure.

**Differences according to sex.**—The size and form of the pelvis differ remarkably in the two sexes. In the female the constituent bones are more slender and less marked with muscular impressions; the perpendicular depth is less, and the breadth and capacity of the true pelvis greater; the ilia however are more vertical, and thus the false pelvis is relatively narrower than in the male; the inlet of the true pelvis is more nearly circular, the sacral promontory projecting less into it; the sacrum is flatter and broader; the depth of the symphysis pubis is less; the pubic arch is much wider, and the space between the tuberosities of the ischia greater.

Fig. 92.

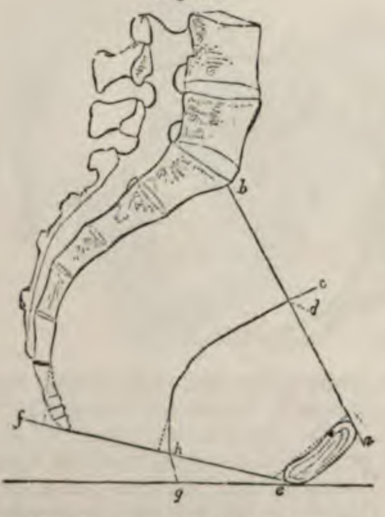


Fig. 92.—SKETCH OF PART OF THE PRECEDING FIGURE, SHOWING THE INCLINATION OF THE BRIM OF THE PELVIS AND ITS AXIS IN THE ERECT POSTURE. ⅓

*a*, *b*, line of inclination of the brim of the true pelvis; *e*, *f*, a line inclining backwards and upwards, touching the lower edge of the symphysis pubis and point of the coccyx; *c*, *d*, axis of the brim at right angles to the plane of the brim; *d*, *h*, *g*, curved axis of the cavity and outlet.

The average dimensions of the pelvis, as measured in a number of full-sized males and females, may be stated as follow, in inches :—

| | MALE. | | | FEMALE. | | |
|---|---|---|---|---|---|---|
| Distance between the widest part of the crests of the ilia . . | 10 to 11 | | | 10½ to 11 | | |
| Distance between the anterior superior spines of the ilia . | 9½ — 10 | | | 10 — 10½ | | |
| Distance between the front of symphysis pubis and the sacral spines | 6½ — 7 | | | 6½ — 7½ | | |
| TRUE PELVIS. | Brim. | Cavity. | Outlet. | Brim. | Cavity. | Outlet. |
| Transverse diameter . . . | 4½ | 4½ | 3½ | 5¼ | 5 | 4¾ |
| Oblique diameter . . . . . | 4¼ | 4½ | 4 | 5 | 5¼ | 4¾ |
| Antero-posterior diameter . . | 4 | 4½ | 3¼ | 4½ | 5¼ | 5 |

The human pelvis, compared with that of the lower animals, is characterised by its shallowness and breadth, and by the great capacity of the true pelvis ; by the expansion of the ilia, the length and sigmoid curve of their crests, the massiveness and straightness of the ischial tuberosities, and the shortness of the symphysis. Similar, although much slighter, variations in the form of the pelvis are to be recognized in the different races of mankind, the most important of which is in the relation of the antero-posterior to the transverse diameter, and is expressed by what is termed the *pelvic index*. This is measured at the pelvic brim ; the transverse diameter is taken as the standard = 100, and the proportion of the antero-posterior diameter to this gives the index. For this purpose the pelves of the two sexes must necessarily be grouped separately, the female having always a lower index than the male ; and the male is usually selected for comparison. The following examples of the average pelvic index in the male of four races will show the range of variation :

| | |
|---|---|
| European (Flower) | 81 |
| Negro (Verneau) | 89 |
| Native Australian (Flower) | 98 |
| Andaman Islander (Flower) | 101 |

## THE FEMUR.

The **femur** or thigh-bone, situated between the hip-bone and the tibia, is the largest and longest bone of the skeleton, its proportion exceeding one-fourth of the height of the whole body. In the erect position of the body it inclines inwards and slightly backwards as it descends, so as to approach inferiorly its fellow of the opposite side, and to have its upper end a little in advance of the lower. It is divisible into a *superior extremity*, including the *head* and *neck* and two eminences called *trochanters*, the *shaft*, and an *inferior extremity* expanded into an *external* and an *internal condyle*.

At the *superior extremity* of the bone, the *neck* extends inwards, upwards, and slightly forwards, being set upon the shaft at an angle of about 125° or 130°. The neck is expanded from above down at its base, where it meets the shaft obliquely, but compressed from before back, so that the vertical diameter greatly exceeds the antero-posterior ; the summit becomes more rounded and is somewhat enlarged again as it joins the head. It is shorter superiorly than inferiorly, and the anterior surface is shorter than the posterior. The *head* forms more than half a sphere, and is covered with cartilage in the fresh state. Behind and below its central point is a small depression, which gives attachment to the interarticular ligament of the hip joint.

Fig. 93.

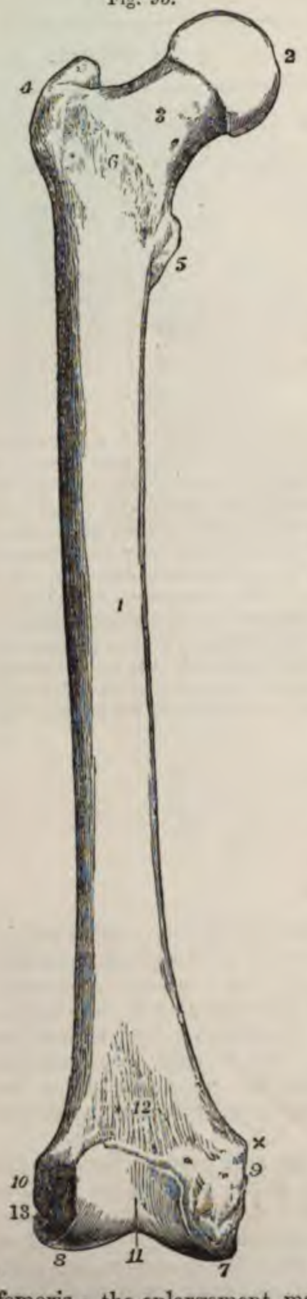


Fig. 93.—Femur of a male from before. (A. T.) $\frac{1}{3}$

1, shaft; 2, head; 3, neck; 4, great trochanter; 5, small trochanter; 6, anterior intertrochanteric line; 7, internal condyle; 8, external condyle; 9, internal tuberosity; ×, adductor tubercle; 10, external tuberosity; 11, the trochlear or patellar surface; above it, 12, the flat part of the femur sometimes called the suprapatellar surface; 13, the depression for the tendon of the popliteus muscle.

The *great trochanter* is a thick truncated process prolonged upwards in a line with the external surface of the shaft. In front it is marked by the insertion of the gluteus minimus; externally an oblique line directed downwards and forwards indicates the inferior border of the insertion of the gluteus medius muscle, and lower down the surface is bounded by a horizontal line, continued upwards in front of the trochanter to an eminence at the junction with the neck, the *tubercle of the femur;* the line marks the upper limit of the vastus externus. Internally at its base, and rather behind the neck, is the *trochanteric* or *digital fossa*, which gives attachment to the obturator externus muscle, while close above and in front of this is the impression of the obturator internus and gemelli muscles. The upper border of the great trochanter is narrow, and presents an oval mark for the insertion of the pyriformis; the posterior border is prominent, and continued into a strong smooth ridge, the *posterior intertrochanteric line*, which passes downwards and inwards to the small trochanter, and limits the neck posteriorly; above the centre the line is thickened, marking the attachment of the upper part of the quadratus femoris; the enlargement may be termed the *tubercle of the quadratus.*

The *small trochanter*, a conical eminence, projects from the posterior and inner aspect of the bone at the junction of the neck with the shaft; its rounded summit gives attachment to the tendon of the psoas and iliacus muscles. The neck is separated from the shaft anteriorly by the *anterior intertrochanteric line*, a broad rough line commencing at the tubercle of the femur and directed obliquely downwards and inwards a finger's breadth in front of the small trochanter; it indicates the attachment of the thick anterior portion of the capsular ligament of the hip and the upper border of the united crureus and vastus internus muscles.

Fig. 94.

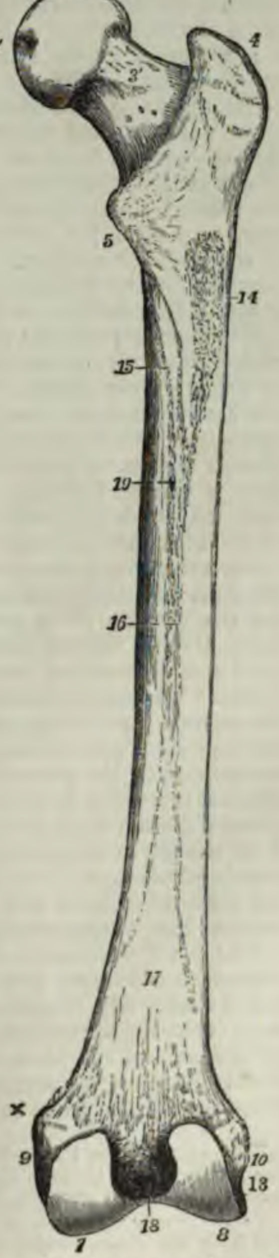


Fig. 94.—Femur of a male from behind. (A. T.) ⅓

4, 5, 7, 8, 9, ×, 10, and 13, as in the preceding figure; 2′, pit on the head for the interarticular ligament of the hip-joint; 3′, the back of the neck, showing a slight groove for the obturator externus muscle as it passes over the capsular ligament and neck; between 4 and 5, the posterior intertrochanteric ridge; 14, gluteal ridge; 15, inner division of upper end of linea aspera; between this and the gluteal ridge is seen the line leading to small trochanter; 16, linea aspera; 17, popliteal surface; 18, intercondylar notch; 19, foramen for the medullary artery.

The *shaft* is arched from above downwards, with the convexity forwards. It is expanded at its upper and lower ends. Towards the centre it is nearly cylindrical, but with a tendency to the prismatic form, due to the projection of the linea aspera behind, and a slight flattening of the surface in front; so that it may conveniently be regarded as presenting an anterior and two lateral surfaces, although definite lines separating the surfaces do not exist. All three surfaces, smooth and uniform, are covered by the crureus and vasti muscles. The lateral surfaces in the middle of their extent approach one another behind, being only separated by the linea aspera. The *linea aspera* is a prominent ridge, extending along the central third of the shaft posteriorly, and bifurcating above and below. It presents two sharp margins or lips and a flat interval. The external lip is prolonged up to the great trochanter, and in its course is strongly marked for about three inches where the gluteus maximus is attached; this *gluteal ridge* is the representative of the third trochanter of the horse and other animals. The internal lip is continued, winding in front of the small trochanter, to the anterior intertrochanteric line, marking the attachment of the vastus internus, and in the interval between the two diverging branches of the linea aspera a less distinct line is seen passing to the small trochanter, and which gives attachment to the pectineus. Inferiorly the two lips are prolonged to the condyles under the name of *internal* and *external supracondylar lines*, enclosing between them a flat triangular surface of bone, the *popliteal surface of the femur*, which forms the floor of the upper part of the popliteal space. The internal supracondylar line is interrupted at the upper part where the femoral vessels lie against the bone; it terminates below in a small sharp projection, the *adductor tubercle*, giving attachment to the tendon of the adductor magnus. Above the centre of the linea aspera is the foramen for the medullary artery, directed upwards into the bone; a second is frequently to be seen near the lower end of the line.

The *inferior extremity* presents two rounded eminences, the *condyles*, united anteriorly, but separated posteriorly by a deep *intercondylar fossa* or *notch*. Their greatest prominence is directed backwards, and their curve, as it increases towards that part, may be compared to that of a partially uncoiled piece of watch-spring. The external condyle is the broader and more prominent in front; the internal is the longer and more prominent inferiorly. One large articular surface, coated continuously with cartilage, extends over both condyles, but, opposite the front of the intercondylar fossa, it is divided by two irregular, slightly marked, transverse grooves into three parts, an elevated surface on each side of the fossa for articulation with the tibia; and a grooved anterior surface for the patella. The patellar surface is of a trochlear form, being marked by a vertical hollow and two prominent lips; the external portion of this surface is more prominent, and rises higher than the internal. The tibial surfaces are nearly parallel, except in front, where the internal turns obliquely outwards to reach the patellar surface. On the exposed lateral surface of each condyle is a rough *tuberosity*, giving attachment to the respective lateral ligament of the knee-joint. The external tuberosity is the smaller of the two; above it is a roundish impression for the outer head of the gastrocnemius, and below and behind it an oblique groove, ending inferiorly in a pit, in which the popliteus muscle takes origin. On the upper part of the internal condyle, between the adductor tubercle and the articular surface is an impression for the internal head of the gastrocnemius.

The head and neck of the femur are deeply placed, the great trochanter is covered only by the aponeurosis of the gluteus maximus, and is readily felt, forming the most prominent part of the hip. The shaft is thickly surrounded by muscles. The condyles are subcutaneous on each side of the knee, the internal being especially prominent; the trochlear surface is concealed by the patella during extension, but in the flexed limb its form can be traced pushing up the muscular covering.

The angle between the neck and shaft of the femur is very open in the child; in advanced age it tends to diminish, and at last may be reduced to a right angle, probably as a result of degenerative processes.

*In the female* the angle of the neck is slightly less obtuse than in the male; and from the greater width of the pelvis, and the shortness of the limbs, the convergence of the thigh bones inferiorly is more apparent.

### THE PATELLA.

The **patella**, *rotula*, or knee-pan, situated at the front of the knee-joint, is attached inferiorly by a ligament or tendon to the tibia, and may be considered as a sesamoid bone developed in the tendon of the quadriceps extensor cruris. It is compressed from before backwards, and has the form of a triangle with the apex below. Its anterior surface is subcutaneous; the superior border is broad, and gives attachment to the extensor muscle; its inferior angle, together with the sharp border on each side, gives attachment to the ligamentum patellæ. The deep surface, except at the inferior angle, is coated with cartilage for articulation with the femur, and is divided by a vertical elevation into two parts, the external of which, the larger, is transversely concave, while the internal is convex.

Fig. 95.

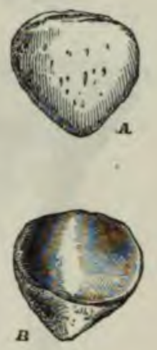


Fig. 95.—Right patella. (A. T.) ⅓

A, from before; B, from behind.

Both views show the lower extremity pointing slightly inwards; the posterior view shows the articular surface, divided by an elevated ridge into a smaller internal and a larger external part.

### THE TIBIA.

The **tibia**, or shin-bone, is, next to the femur, the longest bone in the skeleton. It is the anterior and inner of the two bones of the leg, and alone communicates the weight of the trunk to the foot. It articulates with the femur, fibula, and astragalus.

The *superior extremity* is thick and expanded, broader from side to side than from before backwards, and slightly hollowed posteriorly. On its superior aspect are placed two slightly concave articular surfaces, which sustain the femur. These are the *condylar surfaces;* they are oval in form, the internal being larger than the external, a little more hollowed, and longer from before backwards. Between them is an irregular interval, depressed in front and behind, where it gives attachment to the crucial ligaments and semilunar fibro-cartilages of the knee joint, and elevated in the middle, where is formed the *spine*. The summit of the spine presents two compressed tubercles, formed by the prolongation upwards on its sides of the margins of the condylar surfaces, the inner rising a little higher than the outer. On the sides of the upper extremity of the bone are two massive eminences, the *external* and *internal tuberosities;* the outer of these, somewhat smaller than the other, forms at the junction of its anterior and external surfaces a broad prominent tubercle, and is marked at its posterior and under part by a flat surface which articulates with the fibula, while the inner, which is rounded, presents posteriorly a groove for the insertion of the semimembranosus muscle. Lower down, in front, is situated the *tubercle* or *anterior tuberosity*, marked by the attachment of the ligamentum patellæ.

The *shaft* of the tibia is three-sided, and diminishes in size as it descends for about two-thirds of its length, but increases somewhat towards its lower extremity. The *internal surface* is convex and, for the most part, subcutaneous; at the upper end, by the side of the tubercle, is a slight roughness where the tendons of the sartorius, gracilis, and semitendinosus muscles are inserted. It is separated from the external surface by a sharp, slightly sinuous ridge, the *anterior border* or *crest*, which descends from the tubercle, and is smoothed away in the inferior third of the bone. The *external surface* is slightly hollowed in the larger part of its extent, where it gives origin to the tibialis anticus muscle ; but beneath the point where the crest disappears it turns forwards, becomes convex, and is covered by the extensor tendons. The *posterior surface* is crossed obliquely in its upper third by a rough line, the *popliteal* or *oblique line*, which runs downwards and inwards from the outer tuberosity, and gives origin to the soleus muscle : above this is a triangular area occupied by the popliteus muscle, while below the line, in the middle third of the shaft, a longitudinal ridge divides the surface into two portions, an inner giving origin to the flexor longus digitorum, and an outer, larger, to the tibialis posticus. Near the oblique line is a large medullary foramen directed downwards into the bone. The posterior surface is separated from the internal by a smooth rounded *internal border*, and from the outer surface, by the *external border*, a sharp ridge, inclined forwards above, to which the interosseous membrane is attached.

Fig. 96.

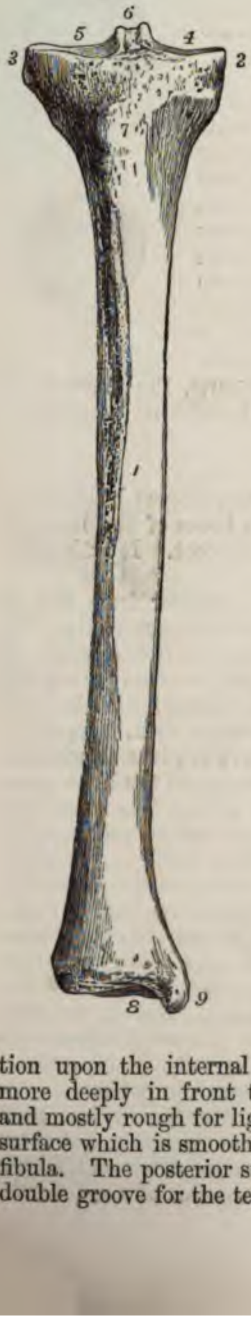


Fig. 96.—Right tibia from before. (A. T.) ⅓

1, shaft, and crest or anterior border ; 2, inner tuberosity ; 3, outer tuberosity ; 4, inner, and 5 outer, condylar articular surface ; 6, spine, with fossa at its root in front ; 7, tubercle ; 8, lower articular surface for astragalus ; 9, internal malleolus.

The *inferior extremity*, much smaller than the superior, is expanded transversely, and projects downwards on its inner side, so as to form a thick process, the *internal malleolus*. Inferiorly it presents for articulation with the astragalus a cartilaginous surface, which is quadrilateral, concave from before backwards, and having its posterior border narrower and projecting farther downwards than the anterior ; internally the cartilaginous surface is continued down in a vertical direction upon the internal malleolus, clothing its outer surface somewhat more deeply in front than behind. The external surface is concave, and mostly rough for ligament, but along the lower border is a narrow surface which is smooth and cartilage-covered for articulation with the fibula. The posterior surface of the internal malleolus is marked by a double groove for the tendons of the tibialis posticus and flexor longus digitorum, and more externally is a slight depression where the tendon of the flexor longus hallucis lies.

The tibia is slightly twisted, so that when the upper extremity has its long diameter directed transversely, the internal malleolus is inclined forwards.

Fig. 97.

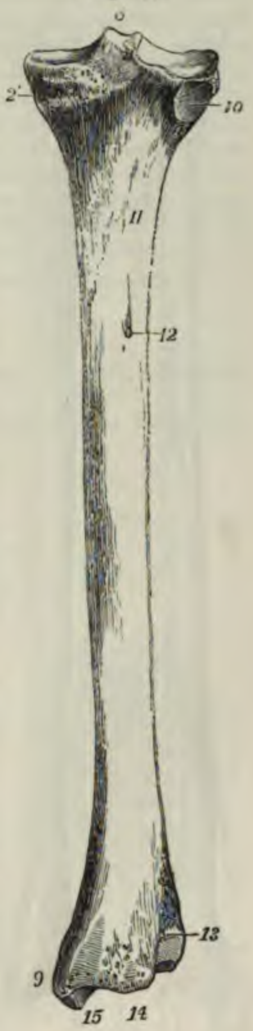


Fig. 97.—RIGHT TIBIA FROM BEHIND. (A. T.) ⅓

6, and 9, as in the preceding figure; 2′, groove behind the internal tuberosity for the tendon of the semimembranosus; 10, articular facet for the head of the fibula; 11, oblique line of tibia, above which is the triangular popliteal surface; 12, medullary foramen directed downwards; 13, triangular rough surface for the lower interosseous ligament, and small cartilaginous surface below it for articulation with the fibula; 14, below a slight groove marking the place of the flexor longus hallucis muscle; 15, below the groove of the tendons of the flexor longus digitorum and tibialis posticus muscles.

Both tuberosities of the tibia are subcutaneous, the external forming a superficial prominence at the outer and fore part of the knee. The internal surface of the shaft is thinly covered for a short distance at the upper part by the tendons of the sartorius, gracilis, and semitendinosus, but in the rest of its extent it is subcutaneous, together with the continuous surface of the internal malleolus. Anteriorly, the tubercle gives rise to a slight elevation below the knee, on which the body is supported in kneeling, and running down from this the crest is to be followed, constituting the shin.

## THE FIBULA.

The **fibula**, or *peroneal bone*, is situated at the outer side of the leg; it is nearly equal to the tibia in length, but is much more slender. Its inferior extremity is placed a little in advance of the superior; and its shaft is slightly curved, so as to have the convexity directed backwards, and, in the lower half, slightly inwards towards the tibia.

The *superior extremity*, or *head*, somewhat expanded, is produced upwards at its hindmost part into a conical eminence, known as the *styloid process;* in front of, and inside this is a small oval cartilage-covered facet, looking upwards, inwards and forwards, for articulation with the outer tuberosity of the tibia; while more externally is a somewhat excavated surface where the tendon of the biceps femoris is inserted: the outer side of the head is smooth and subcutaneous. The somewhat constricted part below the head is distinguished as the *neck*.

The *inferior extremity*, or *external malleolus*, is longer and more prominent than the internal malleolus ; internally it forms the outer limit of the ankle joint, and presents a triangular smooth surface for articulation with the astragalus, behind which is a rough depression where a part of the external lateral ligament is attached : its anterior border, after projecting rather abruptly forwards, slopes downwards and backwards ; posteriorly it is marked by a shallow groove traversed by the tendons of the peronei muscles ; externally it is convex and subcutaneous, and a triangular subcutaneous surface is continued up from it for two or three inches on the shaft.

Fig. 98.

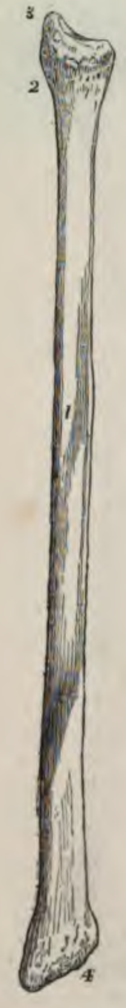


Fig. 99.

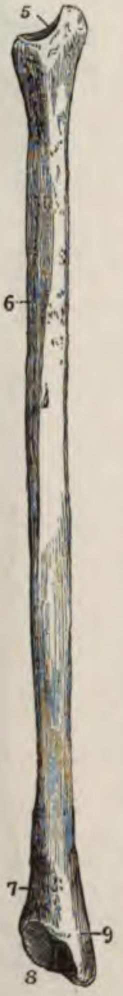


Fig. 98.—Right fibula from the outside. (A. T.) ⅓

1, outer surface of the shaft ; 2, head ; 3, styloid process ; 4, external malleolus, the figure is placed opposite its anterior oblique edge ; above this is seen the triangular subcutaneous surface.

Fig. 99.—Right fibula from the inside and behind. (A. T.) ⅓

5, articular surface on the head for the tibia ; 6, points to the internal surface ; 7, the triangular rough surface for the lower interosseous ligament ; 8, the external malleolar surface for articulation with the astragalus ; 9, groove behind the external malleolus for the tendons of the peronei muscles ; at a little distance below 6, the medullary foramen.

The *shaft* presents four surfaces, separated by as many prominent lines. Three of these lines are known as borders, the fourth is the interosseous ridge. The *anterior border* is the most prominent ; it commences at the fore part of the neck, and takes a straight course down the front of the bone as far as the lower fifth, where it bifurcates, the one line running to the front of the malleolus, the other to the back, and enclosing between them the triangular subcutaneous surface. Immediately internal to this is the *interosseous ridge,* so named from giving attachment to the interosseous membrane ; it is close to the anterior border above, but gradually diverges from that as it passes downwards ; it terminates about an inch and a half above the ankle-joint in the apex of a triangular surface, convex and roughened by the inferior interosseous ligament, fixing it to the tibia. The *external border* extends the whole length of the bone, from the styloid process to the back of the malleolus, inclining inwards in its lower half. The remaining border, *internal,* commences at the inner side of the neck, runs down the shaft for two-thirds of its length, and then ends by joining the interosseous ridge. The surfaces are :—the *anterior,* between the anterior border and the interosseous ridge, narrow above, wider below ; it gives origin to the extensor muscles of the toes and the peroneus tertius: the *external*, broadest of all, somewhat hollowed at the upper part, turning below to the back of the malleolus, thus indicating the course of the peronei muscles, by which it is completely covered; the *posterior*, which winds to the inner side of the bone in its lower half; in its upper third it is rough, giving origin to the soleus, the rest of its extent is occupied by the flexor longus hallucis; and the *internal*, between the internal border and the interosseous line, is a fusiform surface over the upper two-thirds only of the shaft, and giving origin to the tibialis posticus; it is often traversed by an oblique ridge which gives attachment to a tendinous septum in the muscle. The medullary foramen is small, placed on the internal or posterior surface, about the middle, and is directed downwards.

The head of the fibula projects under the skin at the outer and back part of the knee, behind and somewhat below the level of the prominent outer tuberosity of the tibia. The shaft is covered by muscles, except over the triangular surface above mentioned. The external malleolus descends lower and projects farther backwards than the internal, its point being nearer to the heel by about three-quarters of an inch.

## THE TARSUS.

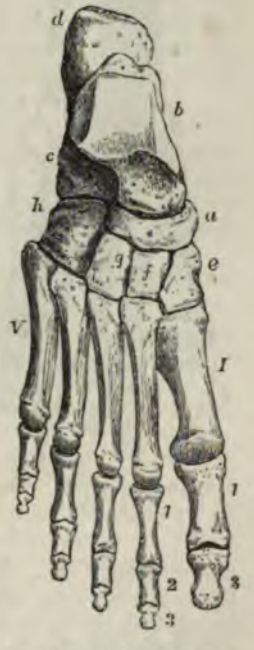
The **tarsus** is composed of seven bones, viz., the calcaneum, astragalus, navicular, three cuneiform, and cuboid.

The **Calcaneum**, or *os calcis*, is the largest bone of the foot. Projecting downwards and backwards, it forms the heel. Above it articulates with the astragalus, and in front with the cuboid bone. Its principal axis extends forwards and outwards from its posterior extremity to the cuboid bone.

Fig. 100.—Right foot, viewed from above, showing its dorsal aspect. (A. T.) ½

*a*, navicular bone; *b*, astragalus; *c*, os calcis; *d*, its tuberosity; *e*, internal cuneiform; *f*, middle cuneiform; *g*, external cuneiform; *h*, cuboid bone. I to V, the metatarsal bones; 1, 3, first and last phalanges of the great toe; 1, 2, 3, first, second, and third phalanges of the second toe.

Fig. 100.



The large posterior extremity, or *tuberosity*, presents inferiorly two *tubercles*, which rest upon the ground, and the internal of which is the larger: its hinder surface is divided into an upper part, smooth and separated by a bursa from the tendo Achillis, a middle part for the attachment of the tendon, and a lower part, convex and roughened, continued below on to the tubercles, and covered by the thick skin and fatty pad of the heel. The part in front of the tuberosity forms a slightly constricted *neck*. The internal surface of the bone is deeply concave, and its concavity is surmounted in front by a flattened process, the *sustentaculum tali*, which projects inwards near the anterior extremity of the bone on a level with its upper surface, and presents inferiorly a groove occupied by the tendon of the flexor longus hallucis. The upper surface presents two articular facets for the astragalus, separated by an oblique groove in which the interosseous ligament is attached; the anterior facet, often subdivided into two, is placed over the sustentaculum, and is concave; the other, posterior and external to this, and larger, is convex from behind forwards and outwards: the outer end of the groove is much widened, and at its fore part is a rough surface where the extensor brevis digitorum takes origin. The anterior extremity articulates with the cuboid bone by a surface concave from above, downwards and outwards, and convex in the opposite direction, and internal to this, along the front of the sustentaculum tali, the inferior calcaneo-navicular ligament is attached. The under surface, projecting in a rough *anterior tubercle*, gives attachment to the inferior calcaneo-cuboid ligaments. The external surface is on the whole flat, but presents at its fore part a variable ridge, the *peroneal spine*, separating two slight grooves, the upper for the tendon of the peroneus brevis, the lower for the peroneus longus.

The **astragalus,** or *talus*, second in size of the tarsal bones, receives the weight of the body from the leg. It articulates with the tibia and fibula above, the os calcis below, and the navicular in front. Its longest axis is directed forwards and inwards. Its main part is called the *body*, the convex anterior extremity is the *head*, and the grooved part behind this is the *neck*. The superior articular surface occupies the whole of the upper aspect of the body, and sends a prolongation downwards on each of the lateral surfaces of the bone. The middle part, looking upwards to the tibia, is convex from before backwards, broader in front than behind, with its outer margin longer than the inner, and curved, while the inner is straight. The inner lateral part is narrow, sickle-shaped, and articulates with the internal malleolus; the outer lateral part, much deeper and triangular, articulates with the external malleolus. Inferiorly, there are two smooth surfaces, which articulate with the calcaneum. The posterior of these, the larger, concave from within outwards and forwards, is separated by a rough depression for the interosseous ligament from the convex anterior surface, which rests on the sustentaculum tali. The rounded surface of the head articulates with the navicular bone, and inferiorly, between this and the anterior articulation with the os calcis, is a small facet which rests upon the inferior calcaneo-navicular ligament, the three forming one continuous articular surface. The posterior border of the bone lies behind the susten-

Fig. 101.

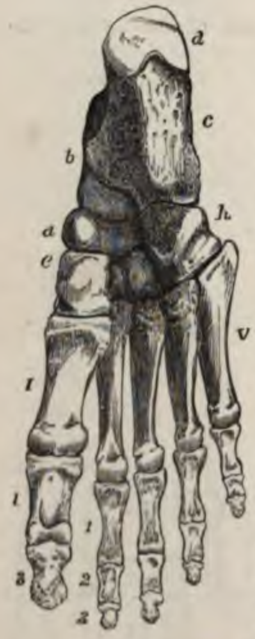


Fig. 101.—RIGHT FOOT VIEWED FROM BELOW, SHOWING THE PLANTAR ASPECT. (A. T.) ⅓

The indications are the same as in the preceding figure; the middle and external cuneiform bones are not lettered; the sesamoid bones are not represented; they will be seen in the view of the articulations of the foot.

taculum tali, and like that process, is grooved by the tendon of the flexor longus hallucis.

The **navicular** or *scaphoid* bone is placed at the inner side of the foot between the astragalus and cuneiform bones. It is elongated transversely, and compressed from before backwards. It presents posteriorly an articular concavity for the head of the astragalus, and anteriorly a convex surface divided by two lines converging below into three facets which articulate respectively with the three cuneiform bones. Its upper surface is convex from side to side, the lower is narrower and very uneven. On the outer end is in some instances a small articular surface for the cuboid bone: the inner end forms the prominent *tubercle*, directed downwards, and giving insertion to the tendon of the tibialis posticus muscle.

The **cuneiform** or wedge-shaped bones are known as first, second, and third, from within outwards, or internal, middle and external. They are placed between the navicular bone and the three inner metatarsal bones, and present anteriorly and posteriorly smooth surfaces for articulation with those bones. The internal cuneiform bone is the largest, the middle is the smallest. The proximal ends of the three bones are in the same transverse line; but at their distal ends the internal and external project forwards beyond the middle one, and thus form a deep recess into which the base of the second metatarsal bone is received.

The *internal cuneiform* bone has its sharp border directed upwards, and the thick rounded base of the wedge projects downwards on the inner border of the foot. The anterior articular surface, for the first metatarsal bone, is much larger than the posterior, is kidney-shaped and convex. The inner surface is free, and presents at its lower and fore part a smooth rounded mark for the tendon of the tibialis anticus muscle: on the outer side, along the posterior and superior borders is an L-shaped surface, which articulates with the middle cuneiform, and at its anterior extremity with the second metatarsal bone.

The *middle cuneiform* bone has its base directed upwards, and the sharp edge downwards towards the sole. The posterior end is somewhat broader than the anterior. On the inner side is an L-shaped articular surface, corresponding to that on the internal cuneiform bone; and on the outer side is a smaller facet, at the posterior part, for the external cuneiform bone.

The *external cuneiform* bone is also situated with its base upwards. At its anterior end is a triangular articular surface for the third metatarsal bone, and continuous with this are two small facets, one on the fore part of each lateral surface, for the second and fourth metatarsal bones. On the internal surface, at the posterior part, is an articular facet for the middle cuneiform bone, and on the outer surface a much larger one for the cuboid bone.

The **cuboid** bone is situated on the outer side of the foot, between the calcaneum and the fourth and fifth metatarsal bones. It deviates from the cuboid form and becomes rather pyramidal, by the sloping of four of its surfaces towards the smaller external border. The posterior surface articulates with the os calcis: the anterior surface is divided into an internal quadrilateral and an external triangular facet, articulating with the fourth and fifth metatarsal bones. On the internal aspect, in the middle, and reaching its superior border, is a smooth surface, which articulates with the external cuneiform bone, and behind this, in some instances, is a smaller surface articulating with the navicular, while the remainder is rough for ligaments. The external border presents a smooth vertical groove, in which the tendon of the peroneus longus lies; and the inferior surface is traversed obliquely near its anterior margin by a continuation of the same groove; behind this there is a thick ridge, which, with the rest of the inferior surface, gives attachment to the calcaneo-cuboid ligaments. The superior surface, looking outwards and upwards, is on the whole even, but rather rough.

### THE METATARSUS.

The five metatarsal bones are distinguished by numbers, according to their position from within outwards. They resemble the metacarpal bones of the hand in being long bones, slightly convex from end to end on the dorsal aspect, in having irregular shaped bases, three-sided shafts, and rounded heads which articulate with the phalanges. They also agree with the metacarpal bones in the number of bones with which each articulates.

The *first metatarsal bone* is the shortest, but is much thicker and more massive than the others. On its base is a large kidney-shaped surface, slightly concave, for articulation with the internal cuneiform bone, and occasionally there occurs a small facet on the outer side for the second metatarsal bone. Of the three surfaces of the shaft, the superior, which looks also inwards, is oblong and convex, the inferior is concave, and the external, the largest, is triangular and flattened, and is marked at its postero-inferior angle by a rounded impression where the tendon of the peroneus longus muscle is inserted. The head is large, and has on its under surface a median ridge, separating two grooves in which the sesamoid bones glide.

The remaining four bones are distinguished from the metacarpal bones by being more slender and compressed from side to side, corresponding to the narrower form of the foot compared with that of the hand. The second is the longest; the others diminish gradually to the fifth. Their shafts present in the greater part of their extent a prominent border looking upwards, which in the middle three appears on the back of the foot between the dorsal interosseous muscles on each side. Their heads are elongated from above down, and terminate below in two small projections; on each side is a tubercle and depression for the attachment of the lateral ligament. The bases differ in the several bones, and thus furnish distinctive characters between them. The *second* has a triangular base, which articulates with the middle cuneiform bone; on the inner side is a small facet for the internal cuneiform; and on the outer side are usually two small surfaces, an upper and a lower, each again subdivided into two, thus making four facets, of which the two posterior articulate with the external cuneiform, and the two anterior with the next metatarsal bone. The *third* has also a triangular base articulating with the external cuneiform bone; on the inner side are usually two facets for the second, and on the outer side a single larger facet for the fourth metatarsal bone. The base of the *fourth* is oblong or oval, and articulates with the cuboid; on the inner side is generally a double facet for the third metatarsal and the external cuneiform bones, but the articulation with the latter is sometimes absent; and on the outer side is a single surface for the fifth metatarsal bone, with a deep groove below it. The *fifth* articulates by its base with the cuboid, and internally with the fourth metatarsal bone, while externally it projects in a large rough tuberosity, into which the peroneus brevis muscle is inserted.

### THE PHALANGES.

The **phalanges** of the toes correspond so nearly in general conformation with those of the fingers that it will only be necessary in this place to state the points in which they differ from the latter.

The phalanges of the four outer toes are much smaller than the corresponding phalanges of the hand; but those of the great toe are larger than those of the thumb. The shafts of the first row of phalanges in the four outer toes are compressed laterally and narrowed in the middle; those of the second row, more especially the fourth and fifth, are very short, their length scarcely exceeding their breadth. The last two phalanges of the little toe are in adults not unfrequently connected by bone into one piece.

SESAMOID BONES.—Two sesamoid bones, developed in the tendons of the flexor brevis hallucis, lie side by side in the plantar wall of the first metatarso-phalangeal joint, and glide in the grooves on the head of the first metatarsal bone. Small sesamoid bones sometimes occur in the corresponding joints of the other toes.

### THE BONES OF THE FOOT AS A WHOLE.

The foot is narrowest at the heel, and as it passes forwards becomes broader as far as the heads of the metatarsal bones. The posterior extremity of the calcaneum is inclined slightly inwards. The astragalus, overhanging the sustentaculum tali, inclines inwards from the calcaneum so much that its external superior border is directly over the middle line of the calcaneum, and hence the internal malleolus appears more prominent than the external. The foot is arched from behind forwards, the posterior pier of the arch being formed by the heel, the anterior by the balls of the toes. The arch, indeed, may be considered as double in front, with a common support behind. The internal division of the arch is that which bears the greater part of the weight of the body, and is most raised from the ground; it consists of the posterior two-thirds of the calcaneum, the navicular and cuneiform bones, and the three inner toes; the outer arch is formed by the calcaneum in its whole length, the cuboid bone, and the fourth and fifth toes. Besides being arched longitudinally, the foot presents likewise a transverse arch, formed behind by the cuboid and three cuneiform bones, and in front by the metatarsal bones.

### OSSIFICATION OF THE BONES OF THE LOWER LIMB.

**Hip-bone.**—The hip-bone is formed from the three principal pieces previously mentioned, viz., the ilium, ischium, and os pubis, and from various others of an epiphysial nature. Ossification commences in the cartilage of the ilium a little later than in other large bones, the deposit of bone beginning above the ilio-sciatic notch in the 8th or 9th week. This is followed by similar deposits in the thick part of the ischium below the acetabulum in the 3rd month, and in the superior ramus of the pubis in the 4th or 5th month. At birth the greater part of the acetabulum, the crest of the ilium, the tuberosity and ramus of the ischium, the body and inferior ramus of the pubis are still cartilaginous; ossification, however, from the three primary centres has extended into the margin of the acetabulum.

In the 7th or 8th year the rami of the ischium and pubis become completely united by bone. The parts which meet in the acetabulum are still separated by a triradiate strip of cartilage, which from its shape has been called the Y cartilage. This cartilage begins to be ossified from one or more centres about the age of puberty, and the intermediate bone or epiphysis so formed is united to the neighbouring parts about the 17th or 18th year. Epiphyses are likewise formed in the cartilage of the crest of the ilium, the tuberosity of the ischium, the anterior inferior spine of the ilium, and the symphysis pubis. These begin to ossify soon after puberty, and unite with the main bone from the 23rd to the 25th year.

Fig. 102.

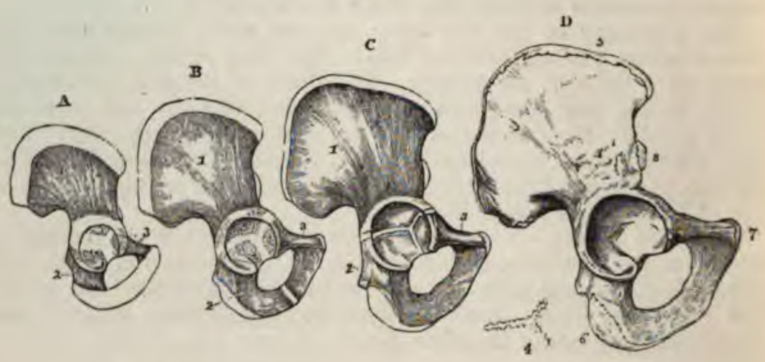


Fig. 102.—Ossification of the hip-bone (R. Quain).

A, the condition of the bone at birth. Bone has spread from three nuclei into the ilium, ischium, and pubis, which meet in the cartilage of the acetabulum.

B, from a child under six years of age. The rami of the ischium and pubis are farther ossified, but still separate.

C, a bone of two or three years later, in which the rami are united.

D, the bone of the right side from a person of about twenty years. Union has taken place in the acetabulum, and the additional epiphyses are seen in the crest of the ilium, the anterior inferior spine, the ischial tuberosity, and the margin of the symphysis pubis.

In A, B, and C, 1, ilium; 2, ischium; 3, pubis; below D, 4, separated Y-shaped piece formed of several fragments which begin to ossify about the 14th year, and often unite into this form before the completion of the acetabulum; 5, epiphysis of the crest; 6, that of the tuberosity of the ischium; 7, that of the symphysis pubis; 8, that of the anterior inferior spine of the ilium.

The *pelvis* of the fœtus and young child is of very small capacity in proportion to the size of the body, and those viscera which are afterwards contained for the most part in the true pelvis occupy a part of the abdominal cavity. The inclination of the pelvis is considerably greater in early life than in the adult.

The **femur** is developed from one principal ossific centre for the shaft which appears in the 7th week, and from four epiphyses, the centres for which appear in the following order;—A single nucleus for the lower extremity appears shortly before birth, one for the head appears in the 1st year, one for the great trochanter in the 4th year, and one for the small trochanter in the 13th or 14th year. These epiphyses become united to the shaft in an order the reverse of that of their appearance. The small trochanter is united about the 17th year, the great trochanter about the 18th year, the head from the 18th to the 19th year, and the lower extremity soon after the 20th year. The neck of the femur is formed by extension of ossification from the shaft.

The **patella** is formed in the 3rd month by a deposit of cartilage in the tendon of the quadriceps extensor cruris muscle. In this cartilage ossification begins from a single centre during the third year, and is completed about the age of puberty.

Fig. 103.

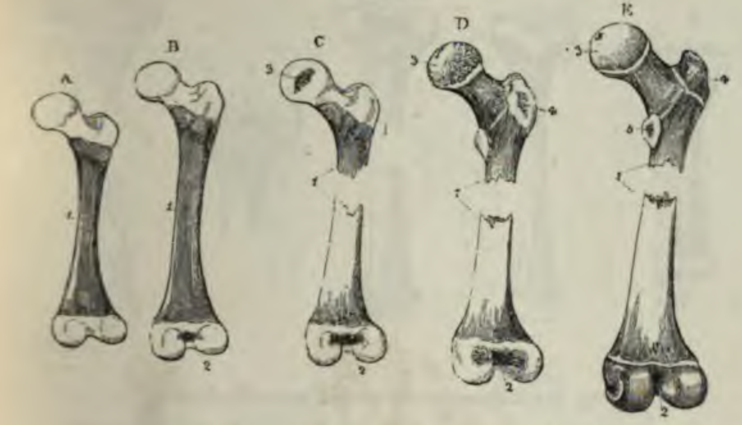


Fig. 103.—Ossification of the femur (R. Quain).

A, from a fœtus under eight months; the body is osseous, both ends are cartilaginous.
B, from a child at birth, showing a nucleus in the lower epiphysis.
C, from a child of about a year old, showing a nucleus in the head.
D, at the fifth or sixth year. Ossification has extended from the shaft into the neck, and a nucleus has appeared in the great trochanter.
E, near the age of puberty, showing more complete ossification and a nucleus in the lesser trochanter.
1, shaft; 2, lower extremity; 3, head; 4, great trochanter; 5, small trochanter.
C, D, & E are represented considerably, A and B very little, under the natural size.

The **tibia** and **fibula** each present, besides the principal centre for the shaft, a superior and an inferior epiphysis. In the tibia the centre for the shaft appears in the 7th week; that for the upper extremity, including both tuberosities and the tubercle, appears most frequently before, but sometimes after birth; and that for the inferior extremity and internal malleolus appears in the 2nd year. The tubercle is occasionally formed from a separate centre. The lower epiphysis and shaft unite in the 18th or 19th year, the upper epiphysis and shaft in the 21st or 22nd year. In the fibula the centre for the shaft appears rather later than in the tibia; that for the lower extremity appears in the 2nd year, and that for the upper, unlike that of the tibia, not till the 3rd or 4th year. The lower epiphysis and shaft unite about the 21st year, the upper epiphysis and shaft about the 24th year.

The **tarsal bones** are ossified in cartilage each from a single nucleus, with the exception of the os calcis, which in addition to its proper osseous centre, has an epiphysis upon its posterior extremity. The principal nucleus of the os calcis appears in the 6th month of fœtal life; its epiphysis begins to be ossified in the 10th year, and is united to the tuberosity in the 15th or 16th year. The nucleus of the astragalus appears in the 7th month; that of the cuboid about the time of birth; that of the external cuneiform in the 1st year; that of the internal cuneiform in the 3rd year; that of the middle cuneiform in the 4th year; and that of the navicular in the 4th or 5th year.

The **metatarsal bones** and **phalanges** agree respectively with the corresponding bones of the hand, in the mode of their ossification. Each bone is formed from a principal piece and one epiphysis; and while in the four outer metatarsal bones the epiphysis is at the distal extremity, in the metatarsal bone of the great toe and in the phalanges it is placed at the proximal extremity. In the first meta-

Fig. 104.

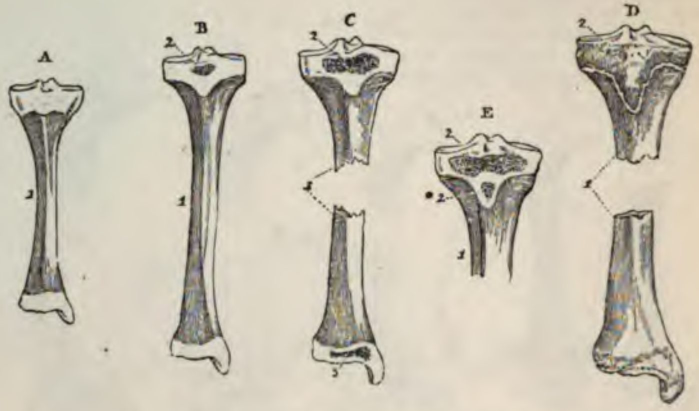


Fig. 104.—Ossification of the Tibia (R. Quain).

A, some weeks before birth; the shaft is ossified; the ends are cartilaginous.
B, at birth, showing the commencement of a nucleus in the upper epiphysis.
C, at the third year, showing the nucleus of the lower epiphysis.
D, at about eighteen or twenty years, showing the lower epiphysis united, while the upper remains separate. The upper epiphysis is seen to include the tubercle.
E, shows an example of a separate centre for the tubercle.
1, shaft; 2, superior epiphysis; 2*, separate centre for the tubercle; 3, inferior epiphysis.

Fig. 105.

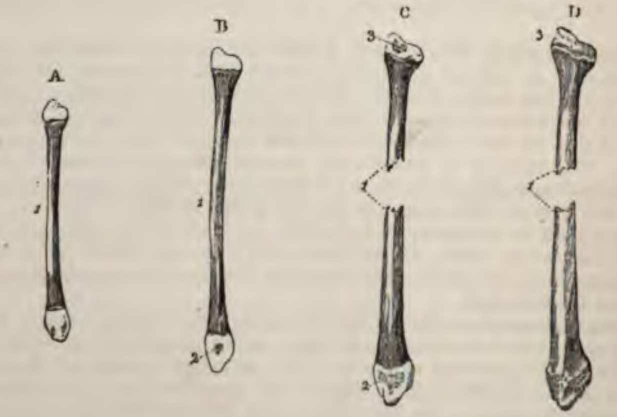


Fig. 105.—Ossification of the Fibula (R. Quain).

A, at birth. The shaft ossified; the ends cartilaginous.
B, at two years, showing a nucleus in the lower epiphysis.
C, at about four years, showing the nucleus of the upper epiphysis; the lower ought to have been shown as more advanced.
D, at about twenty years; the lower end is complete, but the upper epiphysis is still separate.
1, shaft; 2, lower epiphysis; 3, upper epiphysis.

Fig. 106.

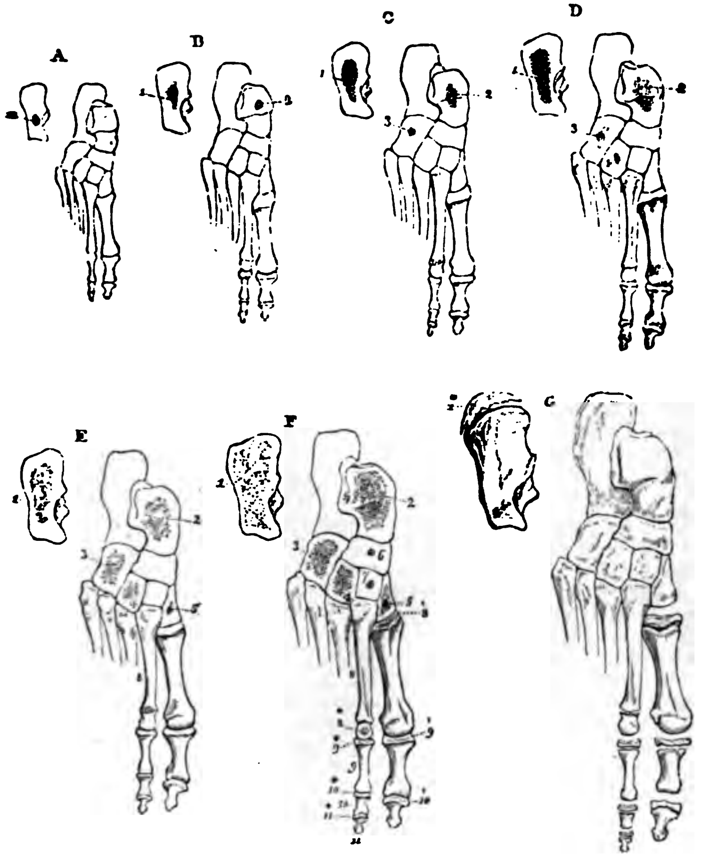


Fig. 106.—Ossification of the bones of the foot (R. Quain).

A, right foot of a fœtus of six months. The metatarsal bones and digital phalanges have each their shafts ossified from their primary centres; the tarsus is wholly cartilaginous, excepting the os calcis, in which the nucleus of bone has just appeared.

B, foot of a fœtus of seven or eight months. The astragalus shows a nucleus.

C, from a child at birth; the cuboid has begun to ossify.

D, about a year old, showing a nucleus in the external cuneiform.

E, in the third year; ossification has reached the internal cuneiform.

F, about four years old, showing ossification in the middle cuneiform and navicular bones, and in the epiphyses of the metatarsal bones and phalanges.

G, about the age of puberty. Ossification is nearly complete in the tarsal bones; an epiphysis has been formed on the tuberosity of the os calcis, and the epiphyses of the metatarsal bones and phalanges are shown separate.

1, nucleus of the os calcis; 1* in G, the epiphysis of the os calcis; 2, nucleus of the astragalus; 3, of the cuboid; 4, of the external cuneiform; 5, of the internal cuneiform; 6, of the navicular; 7, of the middle cuneiform; 8, metatarsal bones; 8*, distal epiphysis of the second metatarsal bone; 8′, proximal epiphysis of the first; 9, first phalanx of the second toe; 9*, proximal epiphysis of this phalanx; 9′, that of the first phalanx of the great toe; 10, second phalanx; 10*, the epiphysis of this phalanx; 10′, epiphysis of the terminal phalanx of the great toe; 11, terminal phalanx; 11*, its epiphysis.

tarsal bone there is also to be observed, as in the first metacarpal (see p. 103), a tendency to the formation of a second or distal epiphysis (A. Thomson). In the metatarsal bones the nuclei of the shafts appear in the 8th or 9th week. The epiphyses appear from the 3rd to the 8th year, and unite with the shafts from the 18th to the 20th year. The nuclei of the shafts of the phalanges appear in the 9th or 10th week. The epiphyses appear from the 4th to the 8th year, and unite with the shafts from the 19th to the 21st year.

## MORPHOLOGY OF THE BONES OF THE LIMBS.

**Relation to the Axial Skeleton.**—Anatomists have generally agreed to look upon the relation which the bones of the limbs bear to the rest of the skeleton as that of appendages to the trunk, hence their distinction as *appendicular* parts of the *axial* skeleton; and most are also disposed to regard these appendages as similar radiations or extensions from one or more of the vertebral segments in two determinate situations of the trunk. But opinions are still divided as to the typical number of the vertebral somatomes which are involved, and as to the exact morphological nature of the parts which form the radiations. The existence in both of a supporting arch in relations somewhat resembling those of the ribs, and the division of this arch at the first joints of the limbs (shoulder and hip-joints) into an upper or dorsal and a lower or ventral section are easily recognised; in the lower limb the dorsal being firmly attached to the side of the sacrum, while in the upper, the ventral part of the arch abuts on the sternum. But it does not appear to be yet determined in the case of the pelvic arch what is the exact morphological nature of the lateral mass of the sacrum, and in both limbs it is still doubtful what is the precise homological relation of the arch to the vertebræ. The fact, however, that a quinquifid division of the peripheral parts of both limbs is constant in man and a certain number of animals, and that in no animals above fishes is there a greater number of elements than five, while in many animals some of the elements may be absent or abortive, together with the remarkably regular passage of a certain number of spinal nerves from the trunk to the limb, of which five are of considerable size in man and those animals possessing the limb elements complete, appears favourable to the view that both limbs have prolonged into them the elements of five vertebral segments, and it is generally held that these elements follow each other in a similar order in the two limbs from the cephalic to the caudal part of the vertebral axis, so that the pollex and radial elements occupy the cephalic side of the upper, while the hallux and tibia take the same place in the lower limb. (See Owen "On the Nature of Limbs," Goodsir "On the Morphological Constitution of Limbs," in Edin. New Philos. Journ., 1857.)

**Homological Comparison of Upper and Lower Limbs.**—A certain anatomical correspondence between the upper and lower limbs, which is apparent to common observation, is admitted in even a fuller degree by most scientific anatomists as the result of a careful comparison of the form, structure, and relations of their bones, as well as of their other parts. But very different views have been taken of the nature and extent of the comparison which may be made between them. Thus Vicq d'Azyr compared the bones of the upper limb of one side of the body to the bones of the lower limb of the other; and Bourgery and Cruveilhier regarded the upper end of the tibia as homologous with that of the ulna, while they compared its lower end to that of the radius. But all such fanciful views have now yielded to the fuller appreciation of homological correspondence which has resulted from a more careful comparison of structure in a wide series of animals, and the study of their transformations in embryonic development; and thus the general conclusion has been formed, that the thoracic and pelvic limbs are constructed on the same general type in man and animals, both as regards the attaching girdles of the shoulder and pelvis, and in the three several sections of which each limb is composed. There are, however, certain modifications of that general plan, leading to considerable differences in the form, size, and number of the individual parts in different animals, which appear to be in a great measure related to the different uses to which the upper and lower limbs are respectively applied; as, for example, in the upper limb of man, the breadth of the shoulders, caused by the interposition of the clavicle, the greater extent of motion in the shoulder joint, the eversion of the humerus, and the forward flexed attitude of the elbow-joint, the arrangements for pronation and supination by rotation of the radius and hand, and the opposability of the thumb, all have reference to the freedom, versatility, and precision of the movements of the upper limb as an organ of prehension and touch; while in the lower limb, the comparatively fixed condition and arched form of the pelvic girdle, the greater strength of the bones, the close-fitting of the hip-joint, the inversion of the femur, the backward flexure of the knee-joint, the arched form of the foot, and non-opposability of the great toe, have all manifest relation to the support of the trunk and pelvis, and their movements upon the lower limbs. In the lower animals, greater modifications in the form of both limbs are to be observed, obviously adapted to their different functions in each case.

Without attempting to follow out this subject by any detailed reference to comparative anatomy or development, it may be useful to state here shortly the more probable conclusions which have been formed with respect to the homological correspondence of the several parts of the upper and lower limbs.*

**Shoulder and Pelvic Girdles.**—With respect to the attaching bones of the two limbs, it is generally held that the blade of the scapula corresponds with the ilium, each of them forming the dorsal section of their respective arches; and the greatest difference between them consisting in the scapula being entirely free from bony articulation with the vertebral column, and capable therefore of considerable motion, while the ilium is firmly jointed to the lateral mass of the sacrum. The ventral part of the shoulder-girdle, completed by the articulation of the clavicles with the sternum, presents no doubt at first sight some similarity to the meeting of the ossa pubis at the symphysis; and thus at one time the clavicle and the pubis were looked upon as homologous bones. But the fuller knowledge of comparative anatomy has more recently led to the adoption of a different view, according to which it appears more probable that the pubis represents rather the precoracoid of the Monotremata and of Reptiles, while, as before believed, the coracoid process of man, originally separate, and typically a distinct bone, is represented in the pelvic girdle by the ischium. Thus, then, it appears that the clavicle is not repeated in the lower limb girdle; and in the place of the very imperfect coracoid process of man and most mammals, there exists in the lower limb a double ventral branch (pubis and ischium) most probably corresponding morphologically to the precoracoid and coracoid of the Monotremata and Reptiles. The clavicle has, indeed, by some been held to be represented by Poupart's ligament, but it seems on the whole more probable that there is no homologue of the clavicular arch in the lower limb. The marsupial bone of the pouched mammals does not represent the clavicle, but lies in the situation of the upper or mesial pillar of the external inguinal aperture.

With regard to the comparison to be established between the individual parts of the scapula and ilium, still greater difficulty prevails than in the general determinations before mentioned. When looked at only in man, the iliac fossa appears at first sight to be the most obvious representative of the subscapular fossa; while the dorsum ilii seems to contain within its limits parts corresponding to both the supra- and infraspinous fossæ. But when our observation extends to a series of different animals, this view loses its apparent probability, and a different mode of comparison is forced upon us. It then appears obvious that the iliac fossa does not at least correspond to the subscapular; but the full determination of the homologies of the different parts of the scapula and ilium, is one of the most difficult parts of this intricate subject. Two different views have lately been brought forward, the one supported by Flower, according to which the scapula and ilium are supposed to have undergone rotation with reference to the axis of the limbs in different directions, the scapula backwards, the ilium

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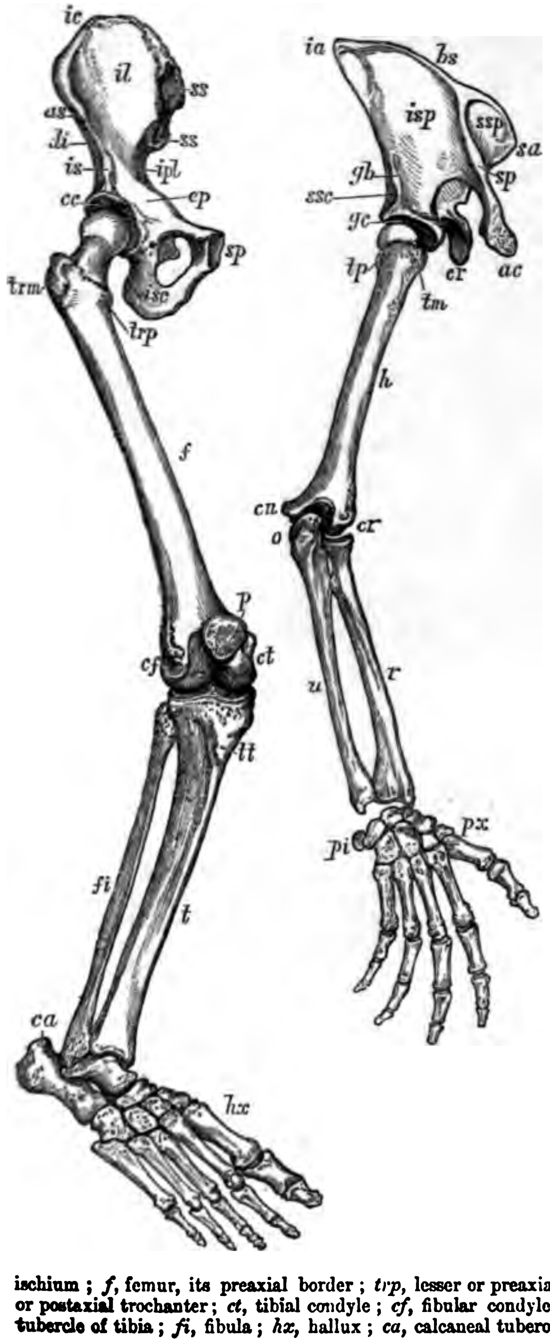
* It is right to mention that, while in the comparison here given most British and European authors coincide, opinions widely different from these are held by several comparative anatomists of distinction in America, among whom may be mentioned Agassiz, Wyman, Wilder, and Coues.

Fig. 108. Fig. 107.



**Figs. 107 & 108.—Sketch of the bones of the thoracic and pelvic limbs so placed as to show corresponding parts in both. (A. T.)** $\frac{1}{8}$

**The preaxial borders of both limbs are towards the reader's right hand, and the dorsal or true extensor surfaces are shown throughout the whole extent of the limbs. The somewhat artificial representation given in these figures cannot be obtained from a single view of the specimens in one position, but it is easily brought out by slightly shifting the bones or changing the point of view. The humeral tuberosities are separated so as to show them on the borders of the bone. Fig. 107, Thoracic Limb: *ssp*, supraspinous or prescapular fossa; *isp*, infraspinous or postscapular fossa; *ssc*, a small part of subscapular fossa; *bs*, base of scapula; *sa*, superior angle; *ia*, inferior angle; *sp*, spine; *ac*, acromion; *cr*, coracoid process; *gb*, glenoid border with place of attachment of triceps muscle; *gc*, glenoid cavity; *h*, humerus, preaxial border; *tm*, large or preaxial tuberosity; *tp*, small or postaxial tuberosity; *cr*, radial condyle; *cu*, ulnar condyle; *r*, radius; *u*, ulna; *o*, olecranon; *px*, pollex side; *pi*, pisiform and postaxial side of hand. Fig. 108, Pelvic Limb: *ss*, sacral surface of ilium; *il*, iliac fossa; *di*, a small part of dorsum ilii or gluteal surface; *ic*, crest of ilium; *as*, anterior superior spinous process; *ipl*, ilio-pectineal line; *ep*, pectineal eminence; *is*, inferior spine and attachment of rectus muscle; *cc*, cotyloid cavity; *sp*, symphysis pubis; *isc*, ischium; *f*, femur, its preaxial border; *trp*, lesser or preaxial trochanter; *trm*, greater or postaxial trochanter; *ct*, tibial condyle; *cf*, fibular condyle; *p*, patella; *t*, tibia; *tt*, tubercle of tibia; *fi*, fibula; *hx*, hallux; *ca*, calcaneal tuberosity.**

forwards, in such a manner that the prescapular fossa (supraspinous of man) corresponds to the sacral surface of the ilium, the postscapular (infraspinous of man) to the iliac fossa or surface, and the subscapular to the gluteal. (See Flower, "Osteology of the Mammalia," and Journ. of Anat., vol iv., 1870.) According to the other view, maintained by Humphry, the prescapular and iliac fossæ are regarded as homologous, and the postscapular fossa as corresponding with the dorsum ilii or gluteal surface, the subscapular surface being represented by the sacral surface of the ilium. (Humphry, in Journ. of Anat., vol. v.: see also Mivart, in Linn. Soc. Trans. 1866, and Rolleston, in the same, 1869.) In the more developed forms of the scapula and ilium, in which the muscular fossæ are of large extent, it is almost impossible to trace the relations now referred to; but in the comparison of the simple forms of these bones which belong to some animals with those of others throughout the series, resemblances are perceived which give to the views of Flower the greater share of probability. In such simpler forms of scapula and ilium these bones may be described as three-sided prismatic rods, in which an internal surface is separated from two external surfaces by anterior and posterior ridges, and the two external surfaces are divided by an external ridge which descends from the dorsal extremity of the bones to the cavity of the joints. It is in this external ridge, glenoid in the scapula and cotyloid in the ilium, and which includes in both the attachment of the great extensor muscle of the limb, that the key to the homologies of the bones is probably to be found. Further observations, especially on the disposition of the muscles, are necessary to determine this question satisfactorily.

**Bones of the Limbs.**—In making the comparison of the bones composing the limbs themselves, it may be proper to revert to the simpler relations subsisting between the limbs and the trunk or vertebral axis of the body in earlier embryonic life, and to remind the reader that there is a determinate and similar position in which the elements of the limb-forming parts are developed from the side of the vertebral stem or trunk (Humphry). In the very earliest stage, while the embryo still occupies the prone position in the blastoderm, the limbs may be said to bud out laterally from the dorsal plates as flattish semilunar flaps, so that they present a dorsal and a ventral surface, coinciding with these respective surfaces of the trunk: but in the next stage, when the limbs come to be folded against the body in the ventral direction, although the original relation to the trunk is undisturbed, their axes have now come to lie nearly perpendicularly to the transverse plane of the vertebral axis, and the position of the limbs is such that in each there is one border which looks towards the head, and another which looks towards the tail. To these borders of the limbs Huxley and Flower have given the names of preaxial and postaxial respectively, as indicating their position before and behind the axis of the limbs. When at a somewhat later stage of development, the divisions of the limbs make their appearance, and more especially when the quinquifid division of the digits in the hand and foot becomes perceptible, it is obvious that the thumb and radius in the one limb, and the great toe and tibia in the other, occupy corresponding cephalic and preaxial

Fig. 109.

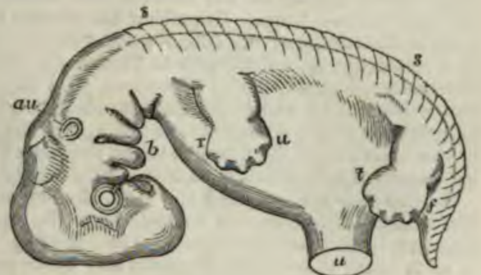


Fig. 109.—LATERAL VIEW OF THE HUMAN EMBRYO OF ABOUT SEVEN WEEKS, SHOWING THE RUDIMENTARY LIMBS IN THEIR SECOND POSITION. (A. T.) MAGNIFIED 7 DIAMETERS.

*r*, preaxial or radial and pollex border of the thoracic limb; *u*, its postaxial or ulnar and little finger border; *t*, preaxial or tibial and hallux border of the pelvic limb; *f*, its postaxial or fibular and little toe border.

situations; and it is not difficult to trace from these the corresponding relations of the parts in the upper division of the limbs; and thus the radial condyle of the humerus with the great tuberosity are preaxial, while the lesser tuberosity, ulnar condyle, ulna, and little finger are postaxial. In the lower limb, the small trochanter, internal condyle, tibia and great toe are preaxial, while the great trochanter, external condyle, fibula, and little toe, are postaxial. And at the same time the dorsal or extensor surface of the limbs is external, and the ventral or flexor surface is internal.

Very soon, however, in the higher animals and in man, farther changes operate in bringing about the permanent form. First, there is the eversion of the humerus so as to place the radial condyle outwards, and the inversion of the femur so as to place the tibial condyle inwards. In the upper limb of man, the radius being in semipronation, no material change occurs in the position of the hand, the thumb hanging naturally forward; but in animals destined to rest on the palmar aspect of the hand or digits, important changes occur in the position of the radius by which, as this bone is brought forward upon the humerus, and its lower end carried inwards, the manus or its elements are placed permanently in the prone position, with the first or radial digit inwards. In the foot no such change is required, as already by the internal rotation of the femur at its upper part, the conditions for plantar support have been secured, and the first or tibial digit is on the inner side. Farther, in man, as the body attains its full development, both limbs are extended in a line parallel to the axis of the trunk, the upper dropping loosely from the shoulder-joint with the greatest freedom of motion; the lower more closely articulated in the hip-joint, and suited to give firm support to the body in the erect posture.

It is proper to mention here a very ingenious view of the homologies of the limbs which has been suggested by Martins, according to which the humerus is to be regarded as virtually twisted upon itself to the extent of 90° at the neck, and 90° more from that part downwards, or to the extent of 180° in its whole length. By this torsion, Martins accounts for the deviation of the external condyle of the humerus from the original or typical position which he considers to remain in the femur, and thus he endeavours to show, and it must be admitted with some plausibility, how, by supposing the humerus to be untwisted, an exact correspondence of the surfaces and borders can be established between the humerus and femur. Gegenbaur has adopted this view, and has added some facts in illustration of it. (Ch. Martins, "Nouv. Compar. des Membres Pelviens et Thoraciques, &c., déduite de la Torsion de l'Humerus." Mem. de l'Acad. de Montpellier, tom. iii., 1857. Gegenbaur, "On the Torsion of the Humerus," in Jenaischen Zeitsch. and Annal. des Sciences Nat., iv., p. 50.) But it is easy to prove, by reference to the embryonic condition, that the actual outward displacement of the lower end of the humerus in the progress of its formation does not exceed 90° in quadrupeds, whilst in man it is considerably less.

Martins has also proposed the view, that in order to compare the leg with the forearm, it is necessary to look upon the upper part of the tibia (corresponding in the main to the radius) as including, or having had transferred to it as it were, the olecranon process and upper part of the ulna; and he thus accounts for the attachment of the great extensor tendon of the leg to the tibia through the patella, which, according to his scheme, represents the olecranon, instead of to the fibula. Ingenious as these views undoubtedly are, they are liable to considerable objections on embryological grounds, and though not to be rejected altogether, cannot be considered as supplying the key to the explanation of the homologies of the limbs.

**Hand and Foot.**—The similarity of the digital and metacarpal bones of the hand with those of the foot in number, form, and connections is so great that the homological correspondence of these bones is immediately recognised. The main differences between them consist in the greater length of the digits of the hand, and the opposability of the thumb to the other fingers through its mobility at the carpo-metacarpal articulation,—conditions which are peculiarly characteristic of man, and do not exist in the same form or degree in any of the lower animals.

Between the carpus and tarsus there is also considerable general similarity, especially in the bones of the distal series; but in those of the proximal row there are some differences which may be referred to here at greater length. There can, indeed, be no doubt as to the homological correspondence of the trapezium, trapezoid and magnum with the internal, middle and external cuneiform bones of the tarsus respectively, nor of the unciform with the cuboid bone; and all the more in the case of the last two bones, that it is found that in the Chelonia and some other reptiles and amphibia, the second series of carpal and tarsal bones are increased to five by the division of the unciform of the hand and cuboid of the foot into two each; thus giving one carpal or tarsal bone for articulation with each of the five metacarpal or metatarsal bones.

Fig. 110.

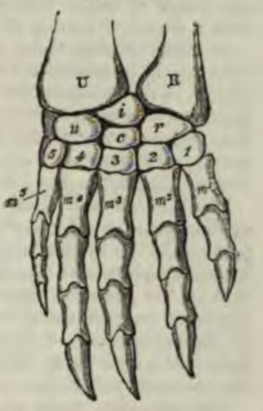


Fig. 110.—DORSAL SURFACE OF THE RIGHT MANUS OF A WATER TORTOISE. (Flower after Gegenbaur.)

R, radius; U, ulna; *r*, radiale; *i*, intermedium; *u*, ulnare; *c*, centrale; 1—5, five carpal bones of the distal row; $m^1$—$m^5$, five metacarpals.

Fig. 111.

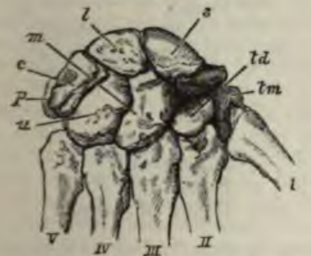


Fig. 112.

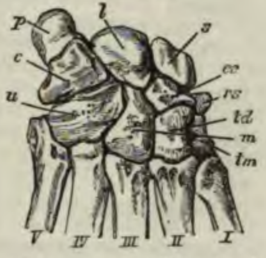


Fig. 111.—DORSAL SURFACE OF THE RIGHT CARPUS OF MAN (Flower). $\frac{1}{2}$

*s*, scaphoid; *l*, lunar; *c*, cuneiform or pyramidal; *p*, pisiform; *tm*, trapezium; *td*, trapezoid; *m*, magnum; *u*, unciform; I—V, five metacarpals.

Fig. 112.—DORSAL SURFACE OF THE CARPUS OF A BABOON (Flower).

*s*, scaphoid; *l*, lunar; *c*, cuneiform or pyramidal; *p*, pisiform; *tm*, trapezium; *td*, trapezoid; *m*, magnum; *u*, unciform; *rs*, radial sesamoid; *ce*, os centrale; I—V, five metacarpals.

Upon the homologies of the proximal series of bones, new light has been thrown by the researches of Gegenbaur, ("Untersuch. zur Vergleich. Anat., &c., Carpus and Tarsus," Leipzig, 1864). In the simplest and most constant form of this series in the carpus, he distinguishes typically three bones, viz., a *radial*, an *intermediate*, and an *ulnar*, corresponding respectively to the scaphoid, lunar and pyramidal bones of human anatomy. The pisiform he regards as an osseous element developed in the tendon of a muscle (flexor carpi ulnaris), and therefore not holding the same rank in the series as the other bones, but constituting an *ulnar sesamoid*. In the foot Gegenbaur shows that the *astragalus* corresponds to the united scaphoid and lunar of the hand, a condition of these two bones not unfrequent among the carnivora, or to the proximal parts at least of these bones. In some mammals (Simiæ and Rodentia), as well as in reptiles and amphibia, another bone, the *os centrale*, has long been known to exist, interposed between the bones of the proximal and distal rows. This element is not represented in the osseous carpus of man, but at an early period of fœtal life a rudiment is present in the form of a small independent cartilage placed between the scaphoid, magnum, trapezium, and trapezoid. As described by Rosenberg and Kölliker it is distinct in the second month, being formed simultaneously with the cartilages of the other carpal bones; it then gradually dwindles from the palmar to the dorsal surface, and by the fourth month has entirely disappeared. (E. Rosenberg, Morphol. Jahrb. i. 83; Kölliker, Entwicklungsgeschichte, 2nd Ed., p. 497.)

The determination of the homology of the navicular bone of the tarsus is not yet fully made out, but it seems most probable that this bone corresponds not to any single or entire bone of the carpus, but rather to the *os centrale*, together with a detached portion of the scaphoid.

In some animals there is a tenth separate bone of the carpus, which seems most nearly to correspond to the tuberosity of the scaphoid: this constitutes the typical *radial sesamoid* of Gegenbaur, and the navicular bone of the tarsus may perhaps correspond to this along with the os centrale. It is interesting to remark that this bone is sometimes found separate in the human hand. (See W. Gruber, Struthers, Turner, and others, in Journ. of Anat., and Mivart "On the Appendicular Skeleton of the Primates" in Philos. Trans. 1867.)

The *os calcis* is generally believed to correspond most nearly with the pyramidal of the carpus, and by some it has been held to include the pisiform,—a view not participated in by Gegenbaur, but of the truth of which any one will be convinced by the inspection of the hand and foot of the bear. It is deserving of remark that in the young of that animal the much enlarged pisiform possesses an epiphysis of its own, exactly similar to the one known as existing on the tuberosity of the calcaneum,—a fact observable also in other animals, and which of itself refutes the view taken by some that the pisiform corresponds to the epiphysis of the calcaneal tuberosity. (Allen Thomson.)

The following tables present a synoptical view of the corresponding or homologous bones or other parts in the thoracic and pelvic limbs.

I.—TABLE OF THE HOMOLOGOUS BONES IN THE THORACIC AND PELVIC LIMBS.

| THORACIC LIMB. | PELVIC LIMB. |
|---|---|
| Scapula | Ilium. |
| Precoracoid | Pubis. |
| Coracoid | Ischium. |
| Glenoid cavity | Cotyloid cavity. |
| Clavicle | *Absent.* |
| Humerus | Femur. |
| Great tuberosity | Small trochanter. |
| Small tuberosity | Great trochanter. |
| External condyle | Internal condyle. |
| Radius | Tibia. |
| Ulna | Fibula. |
| Carpus | Tarsus. |
| Metacarpus | Metatarsus. |
| Pollex | Hallux. |
| Digital phalanges | Digital phalanges. |

II.—TABLE OF THE HOMOLOGOUS BONES OF THE CARPUS AND TARSUS.

| CARPUS. | | TARSUS. | |
|---|---|---|---|
| *Typical Names.* | *Names in Human Anatomy.* | | *Typical Names.* |
| Radiale | Scaphoid | Astragalus | Tibiale. |
| Intermedium | Lunar | | Intermedium. |
| Ulnare | Pyramidal | Os calcis | Fibulare |
| Ulnare sesamoideum | Pisiform | | Fibulare sesamoideum |
| Centrale | *Absent* | Navicular | (Centrale) |
| Radiale sesamoideum | (part of scaphoid) | | (Tibiale sesamoideum) |
| Carpale I. | Trapezium | Int. Cuneiform | Tarsale I. |
| —— II. | Trapezoid | Mid. Cuneif. | —— II. |
| —— III. | Magnum | Ext. Cuneif. | —— III. |
| —— IV. | Unciform | Cuboid | —— IV. |
| —— V. | | | —— V. |

### III.—Table of the Homologous Parts of the Scapula and Ilium (according to Flower).

| Scapula. | Ilium. |
|---|---|
| Supraspinous fossa | Sacral surface. |
| Infraspinous fossa | Iliac fossa. |
| Subscapular fossa | Gluteal or dorsal surface. |
| Base | Iliac crest. |
| Spine and acromion | Ilio-pectineal line and eminence. |
| Superior angle | Posterior superior spine. |
| Inferior angle | Anterior superior spine. |
| Superior or coracoid border | Posterior or ischial border. |
| External or glenoid border | Anterior or cotyloid border. |

## ADAPTATION OF THE SKELETON TO THE ERECT ATTITUDE.

The axial skeleton of man is, for the purposes of station and progression, raised more fully to the vertical position than is the case in any animal; and along with this the lower limbs are extended in lines parallel to the axis of the trunk. The feet rest on the ground by the contact of the heel and the balls of the toes, the centre of gravity of the body falling within the basis of support. For the maintenance of this attitude, the constant action of the muscles passing over the ankle-joint is more immediately necessary. But at the knee and hip-joint, it is mainly by the mechanism of the ligaments and other parts of the joints, and less directly by muscular action, that the erect attitude is maintained, as will be more fully shown in the description of the different articulations.

There are, besides, many peculiarities in the construction of the body, and especially of the skeleton, which are associated with the assumption of the erect posture, and although many of them have been noticed in the description of the several sets of bones, it may still be useful to recapitulate them briefly in this place.

It may first be remarked that the full development of these peculiarities belongs to the adult condition. In the infant, while still unable to walk, the large proportional size of the head, amounting to nearly a fifth of the whole body, the comparative straightness of the vertebral column, or absence of the curves which characterise the spine of the adult, the shortness of the lower limbs, and incompleteness of their structure, all contribute to render the assumption of the erect attitude by the child, for a time, difficult and insecure. Thus the middle distance between the vertex of the head and the foot in a child is situated somewhat above the umbilicus, while in the adult it is generally at the upper border of the pubis, or even lower, in some part of the symphysis. In the child also, from the large dimensions of the head and upper part of the body, the centre of gravity is carried to a considerably higher point than in the adult.

The skull of man differs from that of animals in being nearly balanced on the vertebral column, the condyles of the occipital bone being brought forward to near the middle of the base by the comparative shortness of that part of the skull which lies in front of the foramen magnum, and the projection backwards of that which lies behind it. In animals the skull extends forwards from the extremity of the column, and is sustained by the elastic ligamentum nuchæ, represented in man by a comparatively feeble structure which passes between the external occipital protuberance, and the spinous processes of the cervical vertebræ. Together with this altered relation of the head to the spine, the plane of the foramen magnum, which in quadrupeds is vertical, becomes in man horizontal, or even inclined somewhat upwards anteriorly.

The spinal column, by its pyramidal form, is fitted to sustain the weight which bears down upon its lower part, and by means of its different curvatures possesses elasticity and strength combined, and allows considerable range of motion to the trunk, without removal of the centre of gravity from within its base. The strong and expanded sacrum is the immediate means of transferring the weight of the trunk to the hip-bones and lower limbs.

The pelvis is of peculiar breadth in man, presenting an upper and lower arch which meet at the hip-joints, and is so inclined that a vertical line descending from the centre of gravity of the body is in a plane slightly behind the centres of motion of the hip-joints. The breadth of the pelvis enables the balance to be more easily maintained in lateral movements of the body by compensating inclinations of different parts to opposite sides of the basis of support, and the long neck of the femur gives an advantageous insertion to the muscles by which the balance of the body is principally preserved. The hip-bone is mainly distinguished from the same bone in animals by the breadth of its iliac portion, which gives support to the abdominal viscera, and attachment to the greatly developed iliac and gluteal muscles.

The lower limbs are remarkable for their length and strength. The femur is greatly elongated, its length considerably exceeding that of the tibia,—a condition which is requisite not only to give a sufficient extent of stride, but also to enable the body to be balanced in different degrees and varieties of stooping. The foot of man alone among animals has an arched instep, and it likewise presents a great breadth of sole. The great toe is distinguished by its full development, and especially from that of the quadrumana, by its want of opposability, being constructed. not for grasping, but for supporting the weight of the body, and giving spring to the step.

While stability and strength are thus provided in the lower limbs. mobility and lightness are secured in the upper. This is apparent on comparison of the shoulder, elbow, and wrist, with the hip, knee, and ankle. In the hand, also, the freely moveable phalanges are as long as the carpal and metacarpal bones taken together, while in the foot they are not a third of the length of the tarsal and metatarsal bones.

# ARTHROLOGY.

## THE ARTICULATIONS IN GENERAL.

VARIOUS FORMS OF JOINTS.—The name of articulation, synonymous with joint, is given in descriptive anatomy to the connection subsisting in the recent skeleton between any of its denser component parts, whether bones or cartilages. In all instances some softer substance intervenes between the bones, uniting them together, or clothing the surfaces which are opposed; but the manner in which the several pieces of the skeleton are thus connected varies to a great degree, both as to the nature of the uniting substances, and the extent of movement which they allow. In some instances, as in the cranial bones, the closeness of the apposition, the unevenness of the fitting surfaces or edges, and the small amount and dense nature of the intervening substance (periosteum), admit of no perceptible movement. In other instances of continuous union the extremities of the bones are placed at such a distance, and the intervening substance (ligament or cartilage) is so yielding, that bending or other movements may take place. But in the greater number of articulations the apposed surfaces of bone are not united either directly or mediately with each other, but are free, and are covered with plates of smooth cartilage, the surfaces of which fit accurately together, while the bones are held together by ligamentous structures placed in the vicinity of the joint. In such articulations the bones are capable of gliding or moving upon each other, the extent and directions of such movements varying with the shape of the opposed cartilaginous surfaces, and the form and attachments of the ligamentous and other bands which unite them. It is upon distinctions such as those now adverted to that the various kinds of joints or articulations have been brought under the three classes of Synarthrosis, Amphiarthrosis, and Diarthrosis.

**Synarthrosis** means direct or immediate union, and comprehends the joints with no appreciable motion. It is found chiefly in the various forms of suture by which most of the bones of the head are united. The *suture* is *serrated* or *dentated* when the contiguous margins of the bones are subdivided or broken up into projecting points and recesses by which they fit very closely to one another, as in the borders of most of the tabular bones of the cranium. The *squamous* or *scaly suture* is that in which, as in the union of the temporal with the parietal bone, the edges are thinned and bevelled, so that one overlaps the other to a considerable extent. *Harmonic suture* or *harmonia* is the term employed to denote simple apposition of comparatively smooth surfaces or edges, as in the case of the vertical plate of the palate and the superior maxillary bones: and the term *grooved suture* or *schindylesis* is applied to that kind of union in which one bone is received into a groove in another, as occurs with the rostrum of the sphenoid bone and the vomer.

*Synchondrosis* is another form of immoveable articulation, in which a thin layer of cartilage is interposed between the bones, as in the articulation of the occipital and sphenoid bones in young persons, and the jugular process of the occipital bone with the petrous. In adult age this form of articulation generally becomes converted into bony union, and a similar tendency is observed to a variable degree in the several sutures (p. 58).

**Amphiarthrosis** or Symphysis is the mixed articulation, or that in which there is mediate union by some intervening substance, with partial mobility. The articulations between the bodies of the vertebræ, that between the two pubic bones, and that between the two first pieces of the sternum, may be taken as examples of this mode of connection. Some of the joints of this kind pass on the one hand into synarthrosis, and on the other into diarthrosis.

**Diarthrosis** includes the complete joints, with synovial cavities separating the articular surfaces of the bones, and is attended with considerable yet varying degrees of mobility. In this form of joint plates of cartilage cover the articular parts of the bones and present within the joint free surfaces of remarkable smoothness, and these surfaces are farther lubricated by the synovial fluid secreted from the delicate membrane which lines the fibrous coverings and all other parts of the articular cavity except those formed by cartilage. This membrane is continuous with the margin of the articular cartilages, and along with them completely encloses the joint cavity. The bones are farther held together by fibrous tissue in the various forms of ligaments, such as membranous capsules, flat bands, or rounded cords. These ligaments, it is true, are not so tight as to maintain the bones in close contact in all positions of the joint, but are rather tightened in some positions and relaxed in others, so that in many cases they are to be looked upon chiefly as controllers of movements. The bones are likewise held together in diarthrodial joints by atmospheric pressure, and by the surrounding muscles. The following forms of diarthrodial joint are distinguished :—1. *Gliding joint* (Arthrodia), having nearly flat surfaces, and admitting of only a limited amount of gliding movement, as in the articulations of the carpus and tarsus, and the articular processes of the vertebræ : 2. *Hinge-joint* (Ginglymus), which admits only of flexion and extension, as the elbow and ankle : 3. *Condyloid joint*, allowing all varieties of angular movement and circumduction, as the wrist and metacarpo-phalangeal articulations: 4. *Ball and Socket joint* (Enarthrosis), in which movement can take place in every direction, as the hip and shoulder ; and 5. *Pivot-joint*, as in the case of the atlas and axis, and the upper radio-ulnar articulation, where only rotation is allowed.

VARIOUS KINDS OF MOVEMENT.—The various movements of the bones in diarthrodial joints are distinguished by different terms according to their directions, viz., angular movement, circumduction, rotation, and gliding ; but it is proper to remark that although different kinds of movement, answering to these several terms, may readily be recognised, yet they are seldom of only one kind in any joint, but rather several kinds of movement are frequently combined, and they also run into one another in great variety.

**Angular movement** is movement in such a manner as to increase or diminish the angle between two bones, so that they shall lie more or less nearly in a straight line. The different kinds of angular movement are designated by different terms according to the directions in which they take place with reference to the limb or body: thus *flexion* and *extension* indicate angular movements, which have the effect of bending or straightening parts upon one another or upon the trunk: *adduction* and *abduction* indicate angular movement to and from the mesial plane of the body, or, when fingers and toes are referred to, these terms are generally used to denote movement to and from the middle line of the hand or foot.

*Coaptation* is a form of angular movement, in which, as in the movement of the patella on the femur the articular surface of one bone travels over that of another, so as to bring different parts of the surfaces successively into contact in the manner of a wheel rolling on the ground, this movement being usually accompanied by a certain amount of gliding.

**Circumduction** is the movement performed when the shaft of a long bone or a part of a limb describes a cone, the apex of which is placed in the joint at or near one extremity of the bone, while the sides and base of the cone are described by the rest of the moving part.

**Rotation** signifies movement of a bone round its axis without any great change of situation.

**Gliding** is applied to that kind of movement in which the surfaces of adjacent bones are displaced without any accompanying angular or rotatory motion, as in the movement of flat surfaces over each other in some of the carpal and tarsal articulations, or in the movement of advance and retreat of the lower jaw.

In the various joints provided with synovial cavities, the cartilaginous surfaces of the bones are so formed as usually to be in close apposition or contact; but in certain positions they are not entirely so, and there are even instances in which the separation of the surfaces must be considerable, as in the case of the patella, in some positions of the knee. In these cases the interval is filled up by folds of the synovial membrane, or by fatty processes connected with it.

## ARTICULATIONS OF THE TRUNK AND HEAD.

### ARTICULATIONS OF THE VERTEBRAL COLUMN.

The moveable vertebræ are connected together by elastic discs interposed between the bodies; by synovial joints between the articulating processes; and by ligaments.

The **intervertebral discs** are plates of composite structure placed between the bodies of the vertebræ from the axis to the sacrum. Each is composed of a fibro-laminar part externally, and of a pulpy substance in the centre.

The laminar part forms more than half of the mass. The laminæ are arranged concentrically, and consist mainly of parallel bundles of fibres running obliquely between the vertebræ and attached firmly to both, the direction of the fibres being reversed in successive layers: some fibres also run nearly horizontally. The outermost of these layers consist of ordinary fibrous tissue, but the deeper and more numerous laminæ consist of white fibro-cartilage. The central part of the disc is a pulpy and elastic material which, when the pressure which confines it is taken off by cutting through the intervertebral substance, rises up so as to assume a conical form. It is then seen to be of a lobate structure, and, examined under the microscope, exhibits a finely fibrous matrix, imbedded in which are seen numerous cells, which are not of the nature of cartilage cells, but are united together so as to form a reticular structure, which is closer in the centre of the pulp than towards the periphery. A thin cartilaginous layer covers the upper and lower surfaces of each vertebra and gives attachment to the disc, but it is incomplete towards the circumference, where the epiphyses of the body have been developed in it.

Fig. 113.

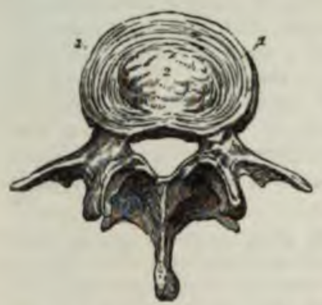


Fig. 113.—A LUMBAR VERTEBRA, SEEN FROM ABOVE, WITH PART OF THE INTERVERTEBRAL DISC ADHERING TO THE BODY. (R. Quain.) ½

1, 1, the fibrous laminæ arranged concentrically; 2, the central soft substance.

It is now generally admitted that the pulp of the intervertebral disc is in part at least a remains of the chorda dorsalis; homologous, therefore, with those larger vestiges of the chorda dorsalis which occupy the biconical cavities between the bodies of the vertebræ in fishes. According to Luschka, there is present in each disc a synovial cavity, and the lobes of the pulp are synovial villi, similar to those which are to be found in the knee and shoulder joints, but of larger size, and occupying the whole cavity; and it is worthy of notice that in like manner secondary cavities, developed within the chorda dorsalis, are found in the intervertebral substance in many fishes. The same author also describes in the cervical region a synovial joint with cartilage covered surfaces, on each side, between the prominent lip of the upper surface of the body of one vertebra and the corresponding portion of the under surface of the body of the vertebra above. (Luschka, "Die Halbgelenke des Menschlichen Körpers," Berlin, 1858.)

The discs are thickest, both absolutely, and relatively to the depth of the vertebral bodies, in the lumbar region, and thinnest in the intervals from the third to the seventh dorsal vertebræ. They form together about a fourth of the length of the moveable part of the column. In the cervical and lumbar regions they are thicker in front than behind,

Fig. 114.

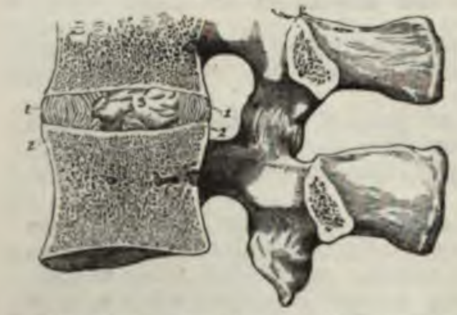


Fig. 114.—SAGITTAL SECTION THROUGH TWO LUMBAR VERTEBRÆ, SHOWING THE ARRANGEMENT OF THE INTERVERTEBRAL DISC. (R. Quain.) ⅔

1, 2, the fibrous laminæ; 3, the central soft substance: the capsule of the joint between the articular processes is represented.

and the curvature of those portions of the column is due principally to the form of the discs.

The **anterior common ligament** (fig. 122, p. 146) is a strong band placed on the front of the bodies of the vertebræ, and reaches from the axis to the first bone of the sacrum, becoming broader as it descends. It consists of longitudinal fibres which are dense, firm, and well-marked. The superficial fibres extend from a given vertebra to the fourth or fifth below it; the fibres beneath these pass over the bodies of one or two vertebræ; whilst the deepest pass only between adjacent vertebræ. The fibres adhere more closely to the intervertebral discs than to the bones, and none are attached over the middle of the bodies, where the ligament is stretched across the transverse depression existing at this part; and by this means the anterior surface of the column, especially in the thoracic region, is rendered more even. Upon the sides of the bodies there are some fibres which are thin and scattered, and reach from one bone to another.

The **posterior common ligament** is situated within the spinal canal, lying on the posterior surface of the bodies of the vertebræ; it extends from the axis to the sacrum. At its upper extremity it is continuous with the posterior occipito-axial ligament. It is smooth and shining, and is broader at the upper than at the lower part of the spine. In the neck it extends quite across the bodies of the vertebræ, but in the back and loins it is broader opposite the intervertebral discs than at the middle of the bodies, so that its margins present a series of points or dentations with intervening concave spaces. It adheres firmly to the discs and to the contiguous margins of the bodies of the vertebræ, but it is separated from the middle of the bodies by the transverse parts of the large venous plexus. Between the ligament and the dura mater which lines the canal some loose connective tissue is interposed.

Fig. 115.

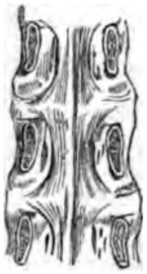


Fig. 115.—The bodies of three lumbar vertebræ, seen from behind, with the posterior common ligament. ½

The arches have been removed by cutting through the pedicles. The narrowing of the posterior common ligament opposite the middle of each body, and its greater width and attachments opposite the intervertebral discs, are represented.

The **joints of the articular processes** present each a synovial cavity surrounded by a fibrous capsule. These capsules are longer and looser in the cervical than in the dorsal and lumbar regions.

Fig. 116.

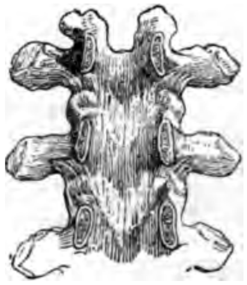


Fig. 116.—The arches of three dorsal vertebræ, seen from before. ½

The bodies of the vertebræ have been removed by sawing through the pedicles, to show the articular capsules and the ligamenta subflava.

The **ligamenta subflava** are ligaments consisting of yellow elastic tissue, which connect the laminæ of the vertebræ from the axis downwards. Their fibres are nearly vertical, and are attached superiorly to the anterior surface of the lamina of one vertebra some distance from its inferior margin, and inferiorly to the upper margin and part of the posterior surface of the vertebra beneath. They are most distinctly seen when the arches are detached from the bodies of the vertebræ, and they are viewed from the front. Posteriorly they appear short, and in the dorsal region are concealed by the prominent inferior margins of the laminæ and the roots of the spines. Their outer margins are close to the articular processes; their inner margins are thickened and in contact with each other beneath the root of the spinous process.

Fig. 117.

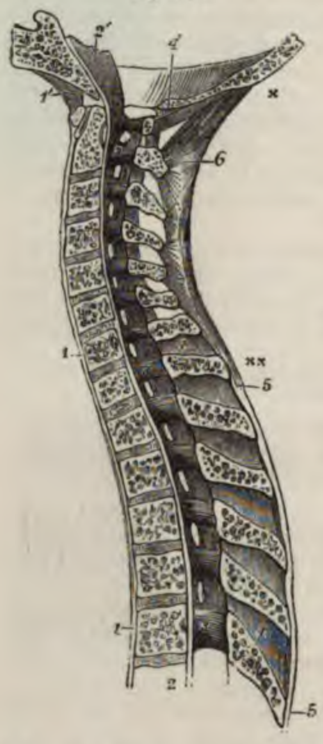


Fig. 117.—SAGITTAL SECTION OF THE UPPER PART OF THE VERTEBRAL COLUMN, AND PART OF THE OCCIPITAL BONE, SHOWING THE ARTICULATIONS. (A. T. after Arnold.)

1, 1, anterior common ligament; 1′, anterior occipito-atlantal ligament; 2, from this figure upwards the posterior common ligament; 2′, the continuation of the preceding or posterior occipito-axial ligament lying on the basilar process of the occipital bone; 3, 3, 3, these figures are placed on the inside of the arches of the 2nd cervical and 1st and 6th dorsal vertebræ; the ligamenta subflava are seen stretching between the laminæ; 4, 4, placed upon two of the interspinous ligaments; 4′, divided edge of the occipital bone behind the foramen magnum, and below it, the posterior occipito-atlantal ligament; 5, 5, supraspinous ligament; 6, ligamentum nuchæ; ×, its upper extremity at the external occipital protuberance; × ×, its lower extremity terminating in the supraspinous ligament.

The **interspinous ligaments,** thin and rather membranous, have an attachment extending from the root to near the summit of each spinous process, and connect the inferior border of one with the superior border of that next below it. They are strongest in the lumbar region, and are least developed in the neck.

The **supraspinous ligament** consists of bundles of longitudinal fibres, which connect the summits of the spinous processes, and form a continuous cord from the seventh cervical vertebra to the sacrum. The superficial fibres pass down from a given vertebra to the third or fourth below it; those more deeply seated reach only from one to the next, or the second below it.

The **ligamentum nuchæ** is the continuation upwards of the supraspinous ligament. It is, in the human subject, a thin intermuscular septum of elastic and white fibrous tissue, the most superficial part of which extends from the spine of the seventh cervical vertebra to the external occipital protuberance, while the deeper fibres, springing from the same origin, pass to the occipital crest, and the spines of the six upper vertebræ. It is the representative of a strong elastic structure which suspends the head in the lower animals.

The **intertransverse ligaments** are unimportant bands extending between the transverse processes. In the lumbar region they are membranous, in the dorsal region they are rounded bundles intimately connected with the muscles of the back; and in the neck they are reduced to a few irregular fibres, which are often wanting.

**Movements.**—The movements of flexion and extension of the vertebral column are freely allowed in the cervical and lumbar regions, but in the dorsal are limited by the small amount of intervertebral substance and the imbrication of the laminæ. The greatest bending backwards is permitted in the cervical, the greatest bending forwards in the lumbar region, especially between the fourth and fifth lumbar vertebræ. Movements in other directions are determined chiefly by the articular processes. In the dorsal region the articular surfaces of each vertebra lie in the arc of a circle whose centre is in front, between the bodies of the vertebræ, and round this centre a certain degree of rotation is permitted. In the lumbar region, the centre of the circle in which the articular surfaces lie is placed behind, so that rotation is prevented; the articular processes, however, permit of lateral flexion, and by combination of this with antero-posterior flexion, some degree of circumduction is produced. The articular surfaces of the cervical vertebræ, being oblique and placed in nearly the same transverse plane, allow neither pure rotation nor pure lateral flexion. They permit, besides forward and backward motion, only one other, which is rotatory round an oblique axis—the inferior articulating process of one side gliding upwards and forwards on the opposing surface, and that of the other side gliding downwards and backwards, by which a combination of lateral flexion and rotation is obtained.

### ARTICULATIONS OF THE ATLAS, AXIS, AND OCCIPITAL BONE.

The atlas, axis, and occipital bone are connected by synovial articulations and ligaments, without the presence of intervertebral discs.

Two pairs of **synovial articulations,** surrounded by capsular ligaments, connect the lateral masses of the atlas with the superior articular surfaces of the axis and with the condyles of the occipital bone. The atlanto-axial capsule is strengthened at the inner and posterior part by an accessory ligament, directed downwards and inwards to the body of the axis near the base of the odontoid process.

The **transverse ligament of the atlas** is a strong and thick band, which extends across the ring of the atlas, and retains the odontoid process in its place. It is attached on each side to the tubercle below the inner border of the superior articular process. It is arched backwards

Fig. 118.

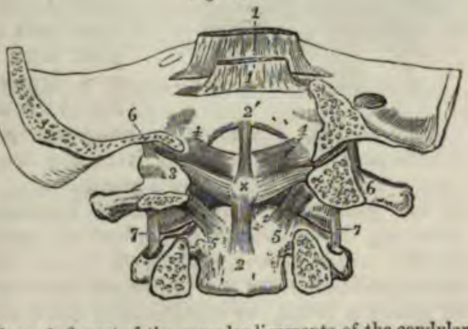


Fig. 118.—FRONTAL SECTION OF THE LOWER PART OF THE OCCIPITAL BONE, AND THE TWO UPPER VERTEBRÆ, BEHIND THE ARTICULATIONS (A. T. after Arnold). ½

1, 1, posterior occipito-axial ligament turned up in two layers; 2, 2′, vertical part, and 3, 3, transverse or principal part of the cruciform ligament; ×, over the neck of the odontoid process; 4, 4, alar or lateral odontoid ligaments; 5, 5, accessory ligaments of the atlanto-axial capsules; 6, 6, part of the capsular ligaments of the condylar articulations; 7, 7, capsular ligaments of the atlanto-axial articulations.

behind the odontoid process, and is broadened out in the middle line. From the middle of its posterior surface a short thin bundle of fibres passes down to be attached to the body of the axis, whilst another passes up to the basilar process. These form, with the transverse portion, the figure of a cross, and from this arrangement is derived the term *cruciform*, which is sometimes applied to the transverse ligament and its appendages together.

Two **synovial cavities** are placed one in front and another behind the odontoid process; the first of these is situated between the process and the anterior arch of the atlas, the other between the process and the transverse ligament.

Fig. 119.

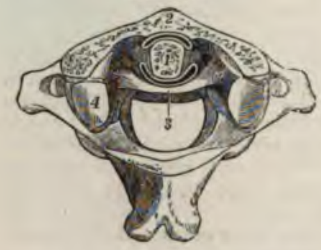


Fig. 119.—Horizontal section through the odonto-atlantal articulation. (A. T.) ½

1, cut surface of the odontoid process; 2, cut surface of the anterior arch of the atlas; 3, transverse ligament; between 1 and 2, the anterior synovial cavity, and between 1 and 3, the posterior synovial cavity of the articulation; 4, is placed on the back part of the left superior articular process of the atlas; the anterior part has been partly removed by the section. For the sake of distinctness, the synovial spaces are represented somewhat wider than natural.

The **lateral** or **alar odontoid** or **check ligaments** are two thick and very strong bundles of fibres, which extend from the sides of the summit of the odontoid process outwards and a little upwards to be implanted into the rough impression on the inner side of each condyle of the occipital bone. Some of the fibres of the two ligaments are usually continuous across the middle line.

Fig. 120.

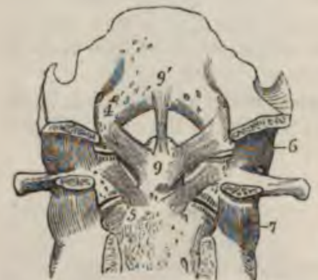


Fig. 120.—Transverse section similar to that shown in Fig. 118, the cruciform ligaments having been removed. (A. T.) ½

4, alar odontoid ligament; 5, accessory atlanto-axial ligament; 6, 7, capsular ligaments of the occipito-atlantal and the atlanto-axial articulations; 9, odontoid process; 9, 9′, middle odontoid ligament.

The **middle odontoid** or **suspensory ligament** consists of fibres which pass directly upwards from the summit of the odontoid process to the margin of the foramen magnum.

The **posterior occipito-axial ligament** is a strong wide band, covering the cruciform and odontoid ligaments. It is attached above in the basilar groove, and below to the body of the axis, and many of the superficial fibres are prolonged into the posterior common ligament, of which it forms the continuation upwards.

The **anterior occipito-atlantal ligament** extends from the anterior border of the occipital foramen, between the condyles, to the anterior arch of the atlas. It is thin, broad, and membranous; but in the median line it is strengthened by an *accessory* ligament, thick and round, placed in front of it, which is sometimes described as the commencement of the anterior common ligament.

The **anterior atlanto-axial ligament,** likewise thin and membranous, except in the middle, where it is considerably thickened, extends from the anterior arch of the atlas to the body of the axis.

Fig. 121.

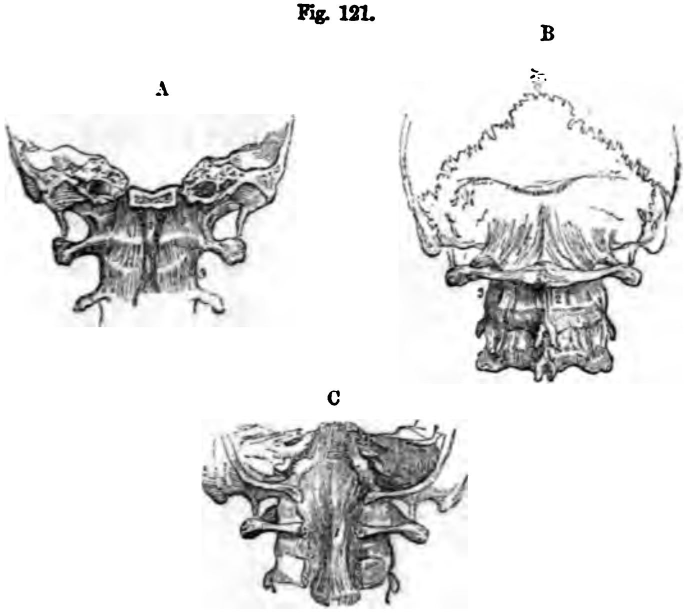


Fig. 121.—THE LIGAMENTOUS STRUCTURES WHICH SURROUND THE ARTICULATIONS OF THE OCCIPUT AND TWO UPPER VERTEBRÆ. ½

A, the lower part of the skull sawn transversely through the basilar process, with the atlas and axis, viewed from before. 1, the anterior occipito-atlantal ligament; 2, the accessory occipito-atlantal ligament; 3, the anterior atlanto-axial ligament.

B, the lower part of the skull, with three adjacent vertebræ, viewed from behind. 1, the posterior occipito-atlantal ligament; 2, the posterior atlanto-axial ligament.

C, the occipital bone sawn transversely through the foramen magnum, and a part of the arches of the atlas and axis removed, so as to show the posterior occipito-axial ligament.

The **posterior occipito-atlantal ligament,** thin and membranous, is attached superiorly to the margin of the occipital foramen behind the condyles, and inferiorly to the adjacent border of the arch of the atlas. It is closely united to the dura mater.

The **posterior atlanto-axial ligament,** similar to the preceding, connects the neural arch of the atlas with that of the axis, in the absence of ligamenta subflava.

**Movements.**—The atlanto-axial articulation is so constructed that the head, together with the atlas, is rotated on the axis; the odontoid process serving as a pivot. The rotation is limited by the check ligaments. The occipito-atlantal articulation takes no part in rotation, but allows the head to be freely raised or depressed upon the vertebral column. When the atlas is placed symmetrically over the axis, it is seen that the opposing articular surfaces, instead of fitting one to the other, come very slightly into contact, the surface of the axis presenting an antero-posterio convexity, to which there is no corresponding concavity presented by the atlas; but a slight rotation brings the bones into a stable position, in which the anterior half of one articular surface of the axis and the posterior half of the other, are laid closely against the atlas. It will also be found that a small amount of oblique motion between the atlas and occipital bone is permitted, by which the anterior half of one condyle and the posterior part of the other may be rested together on the atlas, and that that is the position of greatest stability. This oblique position is that into which the bones are brought when there is any lateral flexure of the column, as is the case in the most natural and easy attitudes.

### ARTICULATIONS OF THE RIBS.

The articulations of the ribs may be divided into three sets, costo-central, costo-transverse, and costo-sternal.

The COSTO-CENTRAL ARTICULATION unites the head of the rib, in most instances, with the bodies of two vertebræ by two distinct synovial joints, supported by ligaments as follows.

The **anterior costo-central** or **stellate ligament** consists of fibres which radiate from the head of the rib to the body of its proper vertebra, to the intervertebral disc, and to the body of the vertebra above. Short fibres surround the remaining portion of the articulation and complete a capsule to the joint.

Fig. 122.

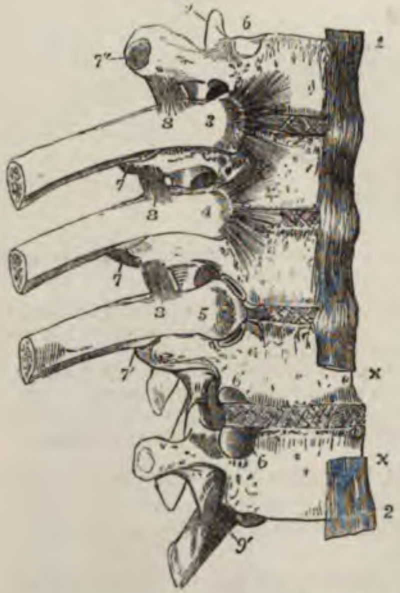


Fig. 122.—THE 5TH, 6TH, 7TH, 8TH, AND 9TH DORSAL VERTEBRÆ, WITH PARTS OF THE 6TH, 7TH AND 8TH RIBS, FROM THE RIGHT SIDE AND FRONT. (A. T.) ½

The 9th rib has been removed to show the articular surfaces of the vertebræ corresponding to it; 3 & 4, the heads of the 6th and 7th ribs, from which the stellate ligaments are seen spreading over the two adjacent vertebral bodies and intervertebral substance; 5, the head of the 8th rib, from which the stellate ligament has been removed, so as to expose the upper and lower synovial cavities, and between them the interarticular ligament; 6, lower, and 6′, upper facet of the costo-central articulation; 7, posterior costo-transverse ligament; 7′, the costo-transverse synovial cavity; 7″, the costo-transverse articular facet; 8, superior costo-transverse ligament; 9, superior articular process of the 5th vertebra; 9′, inferior of the 9th.

The **interarticular ligament** is a thin and short band of fibres, which passes transversely from the ridge separating the two articular surfaces on the head of the rib to the intervertebral substance, and divides the articulation into two parts, each lined by a separate synovial membrane. The ligament does not exist in the articulations of the first, eleventh, or twelfth ribs, as these ribs are each attached to only one vertebral body by a single synovial joint.

The COSTO-TRANSVERSE ARTICULATION unites the tubercle and neck of the rib to the corresponding transverse process by a synovial joint and ligaments, and by a longer ligament to the transverse process of the vertebra above.

The **posterior costo-transverse ligament** is a distinct band extending outwards from the posterior part of the summit of the transverse process to the rough external part of the tubercle of the rib.

The **middle** or **interosseous costo-transverse ligament**, consists of a series of short parallel fibres, which unite the neck of the rib to the anterior surface of the contiguous transverse process. These fibres are seen on removing by horizontal section a portion of the rib and transverse process, and forcibly drawing the one from the other.

Fig. 123.

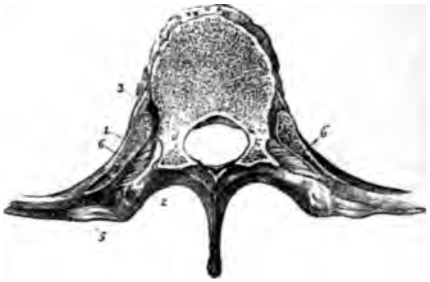


Fig. 123.—HORIZONTAL SECTION OF A DORSAL VERTEBRA, WITH THE ADJACENT PORTIONS OF TWO RIBS. (R. Quain.) ⅔

1, the rib; 2, transverse process; 3, anterior costo-central ligament; 5, posterior costo-transverse ligament; 6, interosseous or middle costo-transverse ligament.

The **superior costo-transverse ligament**, *anterior* or *long*, consists of fasciculi of fibres, passing from the neck of the rib obliquely upwards and outwards to the lower margin of the transverse process next above it. Its internal margin is thickened and free; externally it is continued into the posterior intercostal aponeurosis, which occupies the hinder portion of the intercostal space. This ligament does not exist in the articulation of the first rib.

There are no synovial joints between the lowest two ribs and the transverse processes, and the posterior and middle costo-transverse ligaments are represented by a single band.

The COSTO-STERNAL ARTICULATIONS, situated between the anterior extremities of the cartilages of the sternal ribs and the corresponding fossæ in the margins of the sternum, are, with the exception of the first, small synovial joints, surrounded by short capsules, which are most developed in front and behind, and thus form *anterior* and *posterior ligaments*. The fibres of the anterior ligament radiate from the extremity of the cartilage to the anterior surface of the sternum, where they interlace with those of the opposite side, and are blended with the tendinous fibres of origin of the pectoralis major muscle; the fibres of the posterior ligament are similarly disposed, but are not so thick or numerous. In the second articulation the synovial cavity is divided into two by a short *interarticular ligament*, passing horizontally between the end of the costal cartilage and the cartilaginous layer uniting the manubrium to the body of the sternum; and similar divisions sometimes exist in the succeeding joints. The synovial cavity is frequently wanting in the articulations of the sixth and seventh cartilages. The cartilage of the first rib is almost always directly united to the sternum.

A variable fasciculus of fibres connecting the cartilage of the seventh rib, and sometimes likewise that of the sixth, with the xiphoid cartilage, is called the *costo-xiphoid ligament*.

**Connection of the cartilages one with another.**—The *inter-*

*chondral articulations* are synovial joints, formed by the processes on the adjacent margins of some of the costal cartilages, viz., from the sixth (sometimes the fifth) to the ninth, surrounded by short capsules. The joints are strengthened anteriorly by oblique ligamentous fibres, derived from the anterior intercostal aponeuroses which occupy the fore parts of the intercostal spaces.

**Connection of the ribs with their cartilages.**—The external extremities of the cartilages are fixed into the oval depressions on the ends of the ribs, and the union receives support from the periosteum.

**Ligaments of the sternum.**—The manubrium and body of the sternum are connected by interposed cartilage in which a fissure is sometimes formed, and by anterior and posterior ligamentous fibres, which have chiefly a longitudinal direction. A layer of cartilage also intervenes between the body and ensiform process, so long as they are not united by bone. The whole sternum is much strengthened by thick periosteum, and by the radiating bands of the costo-sternal ligaments already mentioned.

Fig. 124.

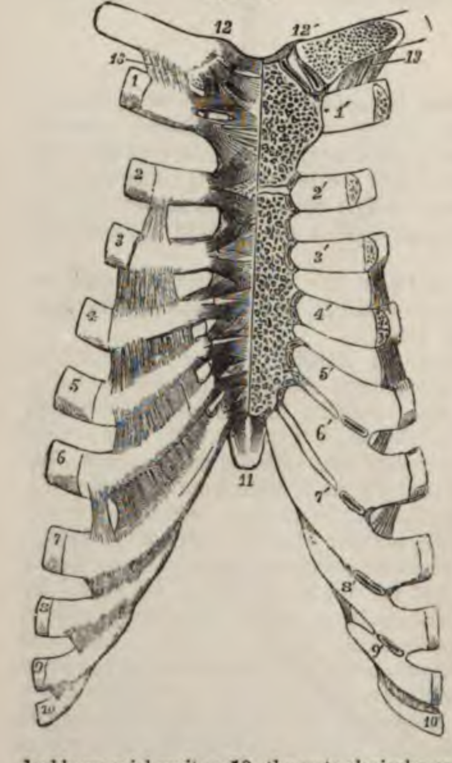


Fig. 124.—ARTICULATIONS OF THE STERNUM, CLAVICLE, AND RIBS, AS SEEN FROM BEFORE. (A. T., after Arnold.) ½

On the right side the anterior ligaments are shown; on the left side, the front parts of the clavicle, sternum and costal cartilages have been removed so as to display the articular cavities. 1 to 10, the anterior extremities of the ribs from the first to the tenth inclusive, on the right side; 1′ to 10′, the costal cartilages of the left side from the first to the tenth; at 1′, the direct union of the first costal cartilage with the sternum is shown; at the sternal ends of the cartilages marked 2′ to 6′, the small synovial cavities are opened; between the costal cartilages on the right side the anterior intercostal aponeuroses are shown stretching over the intercostal spaces; and on the left side, by a section, small synovial cavities are shown between the adjacent edges of the costal cartilages from the 5th to the 9th; on the front of the right half of the sternum the radiating anterior costo-sternal ligaments are shown; 11, the ensiform process; 12, 12′, the interclavicular ligament; and below 12, the anterior sterno-clavicular ligament; below 12′, the sterno-clavicular articulation is opened, showing the interarticular fibro-cartilage and double synovial cavity; 13, the costo-clavicular or rhomboid ligament.

**Movements of the Ribs.**—The heads of the ribs are so tightly bound down to the vertebræ by the interarticular and stellate ligaments that the movements must take place round a centre situated in the costo-central articulation. The ribs generally are capable of a certain amount of elevation and depression, moving upon an axis directed transversely through the costo-central articulations, and of rotation upwards and downwards about an axis passing between their costal and sternal ends, constituting what may be distinguished as the eversion and inversion of the ribs. The movement of the tubercles of the ribs upon the transverse processes is of a gliding nature, and as the planes of the costo-transverse articulations of the lower ribs are directed obliquely, these ribs move backwards as well as upwards in inspiration, and downwards and forwards in expiration. The backward and forward movement is much freer in the case of the last two ribs owing to the absence of the costo-transverse articulation, while the up and down movement is more limited. The first rib can be elevated to a considerable extent, but only very slightly everted, in consequence of the shortness of its cartilage, and the absence of a synovial articulation at the junction with the sternum. When the vertebral column is bent forwards, the ribs are depressed; and when the column is rotated, the ribs of that side towards which the upper part of the trunk is turned are raised, and those of the other side correspondingly depressed. The combined movements of the thoracic walls in respiration will be described with the actions of the intercostal muscles. It is sufficient at present to state that the elevation and eversion of the ribs are the main causes of the antero-posterior and transverse enlargement of the chest in inspiration.

### TEMPORO-MAXILLARY ARTICULATION.

The lower jaw articulates by its condyle on each side with the smooth surface of the temporal bone, extending over the part of the glenoid fossa in front of the Glaserian fissure and the articular eminence formed by the anterior root of the zygoma. The joint is divided by an interarticular fibro-cartilage into an upper and a lower synovial cavity.

Fig. 125.

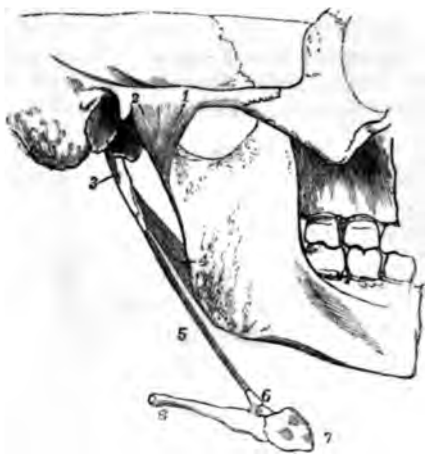


Fig. 125.—A PORTION OF THE SKULL WITH THE LOWER JAW AND HYOID BONE, SEEN FROM THE OUTER SIDE. (A. T., after Arnold.) ½

1, external lateral ligament of the temporo-maxillary articulation; 2, a part of the capsule of the joint; 3, styloid process; 4, stylo-maxillary ligament; 5, stylo-hyoid ligament; 6, lesser cornu of the hyoid bone with some short ligamentous fibres attaching it to, 7, the body, and 8, the great cornu.

The **external lateral ligament** is a short fasciculus of fibres, attached above to the lower border and the tubercle of the zygoma; and below to the external surface and posterior border of the neck of the lower jaw, its fibres being directed downwards and backwards. Scattered ligamentous fibres cover the synovial membrane in front, on the inside, and behind, forming a thin and loose capsule round the joint.

The **internal lateral ligament** is a flat, thin band, placed at some distance from the joint. It extends from the spinous process of the sphenoid bone downwards and a little forwards, to be attached to the inner border of the inferior dental foramen. Between it and the lower jaw are placed the external pterygoid muscle, the internal maxillary vessels, the auriculo-temporal and the inferior dental nerves. It has no immediate connection with the joint, and by some anatomists is not recognised as a ligament.

The **interarticular fibro-cartilage** is a thin plate placed between the articular surfaces of the bones. It is of an oval form, broadest transversely, thickest posteriorly, and thinnest at its centre, where it is sometimes perforated. The inferior surface, which is in contact with the condyle, is concave; the superior is concavo-convex from before backwards, conforming with the articular surface of the temporal bone. Its circumference is attached closely to the capsule, and anteriorly a part of the external pterygoid muscle is inserted into it.

Fig. 126.

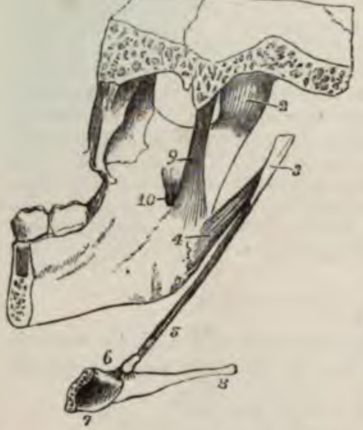


Fig. 126.—A PORTION OF THE SKULL AND LOWER JAW WITH HALF THE HYOID BONE, SEEN FROM THE INSIDE. (A.T.) $\frac{1}{3}$

The numbers are the same as in Fig. 125; 3, styloid process, detached from the skull; 7, posterior surface of the right half of the body of the hyoid bone; 9, internal lateral ligament of the temporo-maxillary joint; 10, inferior dental foramen.

**Synovial Membranes.**—The synovial membrane which lies between the interarticular fibro-cartilage and the glenoid cavity is larger and looser than that which is interposed between the fibro-cartilage and the condyle of the jaw. When the fibro-cartilage is perforated, the upper and lower synovial cavities necessarily communicate with each other.

Fig. 127.

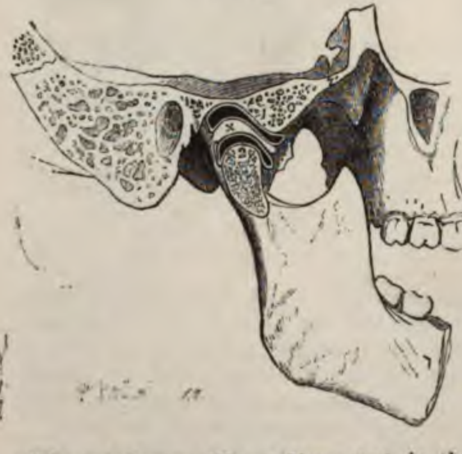


Fig. 127.—SAGITTAL SECTION OF THE TEMPORO-MAXILLARY ARTICULATION OF THE RIGHT SIDE. (A. T.) $\frac{1}{3}$

1, is placed close to the articular eminence, and points to the superior synovial cavity of the joint; 2, is placed close to the articular surface of the condyle of the lower jaw, and points to the inferior synovial cavity of the joint; ×, is placed on the thicker posterior portion of the inter-articular fibro-cartilage.

The **stylo-maxillary ligament** is the name given to a strong thickened band of fibres connected with the cervical fascia extending from the styloid process to the posterior border of the ramus of the jaw, where it is inserted between the masseter and internal pterygoid muscles. It separates the parotid from the submaxillary gland.

*It may* be proper also to mention here the **stylo-hyoid ligament,** a thin fibrous cord, which passes from the point of the styloid process to the lesser cornu of the hyoid bone, and suspends that bone from the styloid process. A considerable portion of the stylo-hyoid ligament is sometimes converted into bone in the human subject, and in many animals it is naturally osseous, constituting the *epihyal bone*.

**Movements.**—The jaw is capable of movements of elevation and depression, and of protrusion and retraction; but it is to be observed that when the jaw is depressed, as in opening the mouth, the condyle advances from the glenoid cavity so as to be placed on the articular eminence in front of it. The movements which take place in the superior and inferior compartments of the joint are of different kinds. In the upper the fibro-cartilage glides forwards and backwards on the temporal bone; in the lower compartment the condyle rotates on a transverse axis against the fibro-cartilage. In opening the mouth the two movements are combined: the jaw and fibro-cartilage together move forwards and rest on the convex root of the zygoma, while at the same time the condyle revolves on the fibro-cartilage. When the lower incisors are protruded beyond those of the upper jaw, the movement is confined chiefly to the upper articulation; and when the same movement is alternately performed in the joints of opposite sides a horizontal oblique or grinding motion is produced. The fibres of the external lateral ligament remain tight in opening the mouth, owing to the descent of the condyle when it passes forwards on to the articular eminence.

## ARTICULATIONS OF THE UPPER LIMB.

### THE SCAPULO-CLAVICULAR ARCH.

The supporting arch of the upper limb has only one point of attachment to the skeleton of the trunk, namely, at the sterno-clavicular articulation; the scapula being connected with the trunk only by muscles.

The clavicle articulates at its inner end with the first bone of the sternum, and is connected by ligaments to its fellow of the opposite side and to the first rib. At its outer end it is united to the scapula.

STERNO-CLAVICULAR ARTICULATION.—The articular surface of the inner end of the clavicle is considerably larger than the opposing surface of the sternum. Between the two bones an interarticular fibro-cartilage is interposed.

The **anterior sterno-clavicular ligament**, broad and consisting of parallel fibres, passes from the front of the inner extremity of the clavicle, downwards and inwards, to the anterior surface of the manubrium.

The **posterior sterno-clavicular ligament**, on the posterior aspect of the joint, is of similar conformation to the anterior ligament, but is not so strongly marked.

The **interclavicular ligament** is a dense fasciculus of fibres passing between the sternal ends of the clavicles. It dips downwards in the middle, where it is attached to the interclavicular notch of the sternum.

The **interarticular fibro-cartilage**, nearly circular in form, and thicker above and at its margins than at the centre, is interposed between the articular surfaces of the two bones. Superiorly it is attached to the upper part of the inner extremity of the clavicle, and inferiorly to the cartilage of the first rib. In the latter situation it is thin and prolonged outwards, beneath the lower border of the clavicle.

**Synovial cavities.**—In this articulation, as in that of the lower jaw, there are two synovial cavities, one on each side of the interarticular fibro-cartilage.

The **costo-clavicular** or **rhomboid ligament** may be regarded as an accessory ligament of the sterno-clavicular articulation. It is attached inferiorly to the cartilage of the first rib near its sternal end, and passes obliquely upwards, backwards and outwards, to be fixed to a rough impression on the under surface of the clavicle near the sternal end.

SCAPULO-CLAVICULAR ARTICULATIONS.—At its outer end the clavicle is connected to the acromion and coracoid processes of the scapula.

The **acromio-clavicular articulation** is a synovial joint uniting the outer extremity of the clavicle with the inner edge of the acromion. It is supported above by a thick and broad *superior ligament*, and below by an *inferior ligament* which is very thin. A small *interarticular fibro-cartilage* is sometimes present. It is wedge-shaped, attached by its base to the superior ligament, and projects only a short distance between the articular surfaces. In rare cases it effects a complete division of the joint.

Fig. 128.

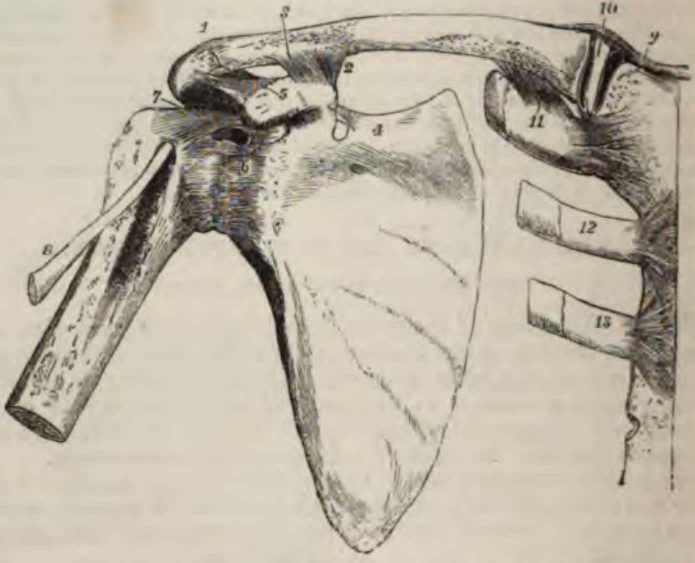


Fig. 128.—VIEW FROM BEFORE OF THE ARTICULATIONS OF THE SHOULDER BONES. (A. T.) ⅓

1, acromio-clavicular articulation; 2, conoid, and 3, trapezoid part of the coraco-clavicular ligament; 4, near the suprascapular ligament; 5, on the coracoid process, points to the coraco-acromial ligament; 6, capsular ligament of the shoulder joint; 7, coraco-humeral ligament; above 6, an aperture in the capsular ligament through which the synovial membrane is prolonged under the tendon of the subscapularis muscle; 8, tendon of the glenoid head of the biceps muscle; 9, right half of the interclavicular ligament; 10, interarticular fibro-cartilage of the sterno-clavicular articulation; 11, costo-clavicular ligament; 12 and 13, cartilage and small part of the second and third ribs attached by their anterior costo-sternal ligaments.

The **coraco-clavicular ligament,** which connects the clavicle with the coracoid process of the scapula, is divisible into two parts. The *conoid ligament*, which is the posterior or internal fasciculus, broad above, narrow below, is attached inferiorly to the inner part of the root of the coracoid process, and superiorly to the conoid tubercle of the clavicle: its fibres are directed backwards and upwards. The *trapezoid ligament*, the anterior or external fasciculus, slopes upwards, backwards, and outwards from the upper surface of the coracoid process to the trapezoid line, on which it is inserted into the clavicle. In the angle between the conoid and trapezoid ligaments there is frequently a synovial bursa.

**Movements.**—The clavicle is firmly bound down at its inner end in the sterno-clavicular articulation, and upon this as a centre it can be moved upwards and downwards, forwards and backwards, or in any intermediate direction, necessarily carrying the scapula with it, which glides in a corresponding direction over the thoracic wall. The scapula farther undergoes a movement of rotation, by which the acromion is raised and the glenoid cavity directed upwards when the arm is elevated, and the reverse when the arm is depressed. The movements of the bones are limited, not so much by the forms of the articular surfaces, as by the costo-clavicular and coraco-clavicular ligaments, and the position of the thoracic wall. When the clavicle is forcibly depressed, as in lifting a heavy weight, it presses upon the first rib, its sternal end rises, and the interarticular fibro-cartilage and interclavicular ligament are put upon the stretch. The acromio-clavicular joint is loose and allows of considerable play, by which the angle between the spine of the scapula and the clavicle is altered as the shoulder is moved; and the scapula is supported on the clavicle principally by the strong coraco-clavicular ligament.

LIGAMENTS OF THE SCAPULA.—There are two ligaments which stretch from one part of the scapula to another. 1. The **coracoid** or **suprascapular ligament** is a thin, flat band of fibres, attached by its extremities to the opposite margins of the notch at the root of the coracoid process, which it thus converts into a foramen for the transmission of the suprascapular nerve, the corresponding artery most commonly passing above it. This ligament is frequently converted into bone. 2. The **coraco-acromial ligament**, broad, firm, and triangular, is attached by its broader extremity to the outer edge of the coracoid process, and by the narrower to the tip of the acromion. Its inferior surface looks downwards upon the shoulder-joint, the superior is covered by the deltoid muscle. It completes the arch formed by the coracoid and acromion processes, and gives protection to the shoulder-joint.

### THE SHOULDER-JOINT.

In this articulation the large and hemispherical head of the humerus is opposed to the much smaller surface of the glenoid cavity of the scapula. The bones are retained in position, not by the direct tension of ligaments, which would restrict too much the movements of the joint, but by surrounding muscles and atmospheric pressure.

The **capsular ligament** is attached to the scapula round the margin of the glenoid cavity, and to the humerus at the place where the neck springs from the tuberosities and shaft. It extends farthest down the humerus on the internal or inferior aspect, and is strongest on the superior aspect. It is so lax that the humerus separates from the glenoid cavity as soon as its muscular connections are detached. Superiorly and posteriorly the capsule is strengthened by the tendons of the supraspinatus, infraspinatus, and teres minor muscles, which are intimately connected with it as they pass over it to reach the great tuberosity of the humerus. Anteriorly the tendon of the subscapularis muscle comes into direct contact with the synovial membrane, which is prolonged upon it through an oval opening in the capsule. The insertion of the capsule is likewise interrupted opposite the bicipital groove, to give passage to the long tendon of the biceps muscle.

Fig. 129.

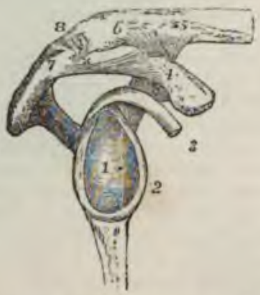


Fig. 129.—VIEW OF THE GLENOID CAVITY AND LIGAMENTS BETWEEN THE SCAPULA AND CLAVICLE OF THE RIGHT SIDE. $\frac{1}{3}$

1, glenoid fossa, its cartilaginous surface ; 2, glenoid ligament ; 3, tendon of the biceps muscle seen in connection with the upper part of the glenoid ligament ; 4, upper surface of the coracoid process ; 5 and 6, on the adjacent part of the clavicle ; 4 to 5, the conoid, 4 to 6, the trapezoid portion of the coraco-clavicular ligament ; 7, apex of the acromion process ; 4 to 7, coraco-acromial ligament ; 8, acromio-clavicular articulation, which is open anteriorly, showing a wedge-shaped interarticular fibro-cartilage attached above to the superior acromio-clavicular ligament ; ×, the inferior acromio-clavicular ligament.

The **coraco-humeral**, or accessory ligament, is a strong wide band extending obliquely over the upper part of the articulation ; it springs from the root and outer border of the coracoid process, and thence passes to the neck of the humerus above the great tuberosity, intimately connected with the capsule. A few anterior fibres of the ligament project into the joint, and are inserted into the inner margin of the upper end of the bicipital groove ; these have been called the *gleno-humeral* ligament, and are supposed to correspond to the interarticular ligament of the hip-joint.

Fig. 130.

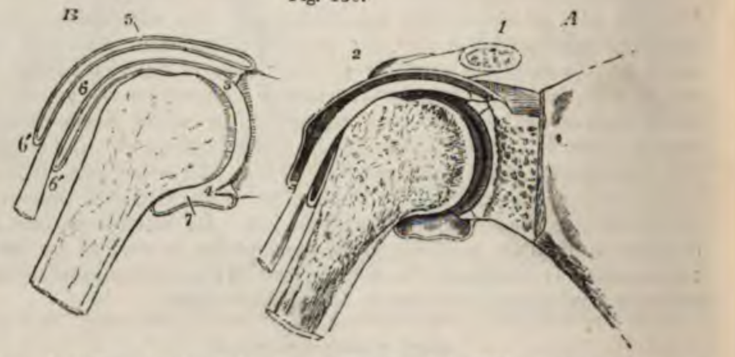


Fig. 130.—A, SECTION THROUGH THE SHOULDER-JOINT, TENDON OF THE BICEPS AND BICIPITAL GROOVE, SHOWING SOMEWHAT DIAGRAMMATICALLY THE SYNOVIAL CAVITY OF THE JOINT, &c. (A.T.) $\frac{1}{3}$

B, OUTLINE OF THE SAME, TO SHOW THE REFLECTION OF THE SYNOVIAL MEMBRANE OVER THE TENDON.

1, outer part of the clavicle ; 2, the acromial end ; 3, cavity of the shoulder-joint close to the upper part of the head of the scapula, where there are seen the section of the cartilages on the head of the humerus and in the glenoid cavity, the glenoid ligament and the origin of the tendon of the biceps muscle ; 4, glenoid ligament in the lower part of the cavity ; 5, upper part of the capsular ligament and synovial membrane ; 6, tendon of the biceps as it passes out of the joint into the bicipital groove ; 6′, 6′, tubular prolongation of the synovial membrane round the tendon ; 7, reflection of the synovial membrane on the humerus within the lower part of the capsular ligament.

The **glenoid ligament** is a fibrous band, about two lines thick, which is fixed to the edge of the glenoid fossa, and thus deepens the cavity. The upper part of it is connected with the tendon of the long head of the biceps muscle, which is also attached at the upper end of the glenoid fossa, within the capsule of the joint.

The **synovial membrane** is reflected uninterruptedly from the margin of the glenoid cavity on the inner surface of the fibrous capsule to the humerus, but its form is complicated by its relation to the tendons of the biceps and subscapularis muscles. The long tendon of the biceps muscle, traversing the joint in its course from the upper border of the glenoid cavity to the bicipital groove, is enclosed in a tubular sheath, formed by a process of the synovial membrane, which is continued down upon it beyond the fibrous capsule into the bicipital groove, and is thence reflected upwards lining the groove, to become continuous with the synovial membrane of the capsule in such a manner as to preserve the integrity of the membrane. The bursal prolongation of the synovial membrane under the tendon of the subscapularis muscle is of variable extent, sometimes scarcely existing, sometimes forming a considerable pouch on the venter of the scapula.

**Subacromial Bursa.**—Superficial to the muscles covering the top of the joint is a considerable bursa, by means of which the contiguous surfaces of the acromion process, of the coraco-acromial ligament and of the deltoid muscle, are lubricated, so as to facilitate the movements of the subjacent head of the humerus.

**Movements.**—The shoulder-joint, being a ball and socket joint, allows of angular movement in all its varieties, as well as of rotation. In flexion the arm is carried forwards and somewhat inwards, in extension backwards and somewhat outwards; in abduction and adduction the humerus moves in directions more or less at right angles to the foregoing. The movements of extension and adduction are very limited, being restrained by the coraco-humeral ligament. Flexion and abduction are the movements by which the humerus is raised, and are admitted to the extent of 90°, but are then checked by the upper end of the bone meeting the coraco-acromial ligament, and farther elevation of the arm is effected by the rotation of the scapula before described. In rotation the humerus revolves about its long axis; the whole range of the movement is about a quarter of a circle. The arch formed by the acromion, the coracoid process, and the coraco-acromial ligament, lined by the subacromial bursa, forms a sort of secondary socket in which the extremity of the humerus, covered by the tendons inserted into the great tuberosity, revolves, and against which it is pressed when the weight of the body is made to rest upon the arms.

## ARTICULATIONS OF THE BONES OF THE FOREARM.

The bones of the forearm are united by a superior and an inferior articulation and an interosseous membrane.

In the SUPERIOR RADIO-ULNAR ARTICULATION the head of the radius is received into the small sigmoid cavity of the ulna and is held in position by the **annular** or **orbicular ligament**. This ligament is a strong band of fibres attached to the ulna in front and behind, at the extremities of the small sigmoid cavity, and forming about four-fifths of a ring which encircles the head of the radius and binds it firmly in its situation. The external lateral ligament of the elbow is inserted into its outer surface; its deep surface is smooth, and is lined by the synovial membrane of the elbow-joint.

The INFERIOR RADIO-ULNAR ARTICULATION.—The connection between the sigmoid cavity of the radius and the lower end of the ulna is effected by means of a fibro-cartilage, a synovial membrane, and some scattered ligamentous fibres in front and behind. The **triangular fibro-cartilage** is a thick plate attached by its base to the border separating the carpal from the ulnar articulating surface of the radius ; and by its apex to a depression at the root of the styloid process of the ulna, and to the side of that process. Its upper surface looks towards the ulna, its lower towards the semilunar bone, and it separates the inferior radio-ulnar articulation from the wrist-joint. The **synovial membrane**, sometimes called from its looseness *membrana sacciformis*, extends upwards between the radius and ulna, and horizontally inwards between the ulna and triangular fibro-cartilage. When the fibro-cartilage is perforated, as is frequently the case, this synovial cavity communicates with that of the wrist-joint.

Fig. 131.

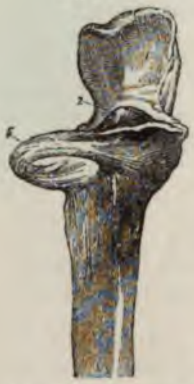


Fig. 131.—THE UPPER PART OF THE ULNA, WITH THE ORBICULAR LIGAMENT (R. Quain). $\frac{1}{2}$

1, upper division of the sigmoid surface on the olecranon ; 2, extremity of the coronoid process ; 5, orbicular ligament.

The **interosseous membrane** or **ligament** of the forearm is a thin, flat, fibrous membrane, the direction of whose fibres is for the most part obliquely downwards and inwards, from the interosseous border of the radius to that of the ulna. Its superior border is placed about an inch below the tubercle of the radius, leaving an open space above (hiatus interosseus) through which the posterior interosseous vessels pass. This space is bounded above by the **oblique** or **round ligament**, a thin, narrow fasciculus of fibres extending obliquely downwards and outwards from the coronoid process, to be attached to the radius below the tubercle. Other small bundles of fibres, having the same direction as the oblique ligament, are often to be found at intervals, decussating with the fibres of the interosseous ligament on its posterior surface.

Fig. 132.

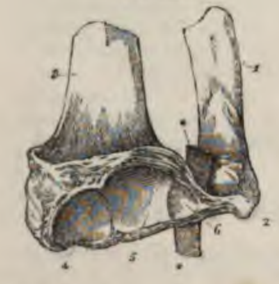


Fig. 132.—THE LOWER PARTS OF THE RADIUS AND ULNA, WITH THE TRIANGULAR FIBRO-CARTILAGE CONNECTING THEM (R. Quain). $\frac{2}{3}$

1, ulna ; 2, its styloid process ; 3, radius ; 4, articular surface for the scaphoid bone ; 5, that for the semilunar bone ; 6, lower surface of the triangular fibro-cartilage ; * *, a piece of whalebone passed between the fibro-cartilage and the ulna.

**Movement of the Radius on the Ulna.**—The disposition of the annular ligament allows the head of the radius to rotate freely within it, while the lower end of the radius, bound by the triangular fibro-cartilage to the styloid process of the ulna, has a movement of circumduction round that point, by which the hand is brought into the prone or the supine position. Thus in pronation and supination the radius describes a part of a cone, the axis of which extends from the centre of the head of the radius to the styloid process of the ulna.

### THE ELBOW-JOINT.

The lower extremity of the humerus is in contact with the ulna and radius at the elbow, and forms with them a hinge-joint. The great sigmoid cavity of the ulna articulates with the trochlea of the humerus, so as to admit of flexion and extension only; while the cup-shaped depression on the head of the radius is fitted to turn freely on the rounded capitellum. These bones are united principally by strong lateral ligaments.

The **internal lateral ligament**, triangular in shape, consists of anterior and posterior thickened bands, and an intermediate thinner part.

Fig. 133.

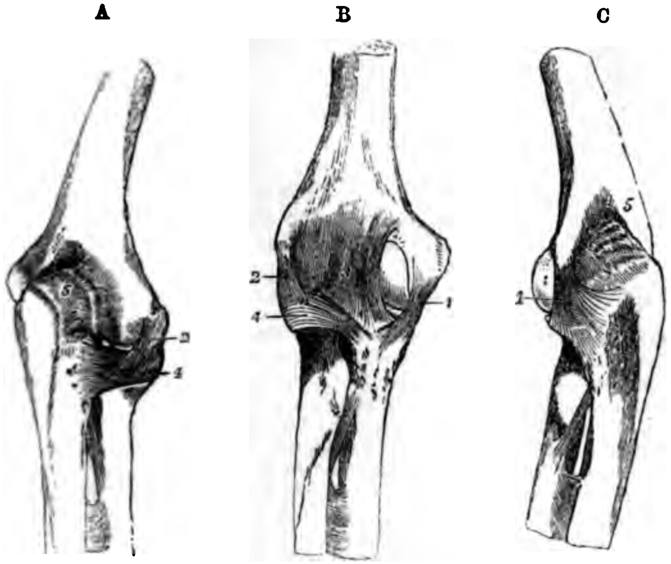


Fig. 133.—LIGAMENTS OF THE ELBOW-JOINT. (A. T.) ⅓

A, from the outer side and behind; B, from the front; C, from the inner side and behind. 1, internal lateral ligament; 2, external lateral; 3, the middle strongest part of the anterior ligament; 4, orbicular ligament; 5, posterior ligament, represented as wrinkled from relaxation in extension. In these figures the oblique ligament and upper part of the interosseous membrane are also represented below the elbow-joint.

The anterior band springs from the lower and fore part of the internal condyle of the humerus, and is inserted into the coronoid process, along the inner margin of the sigmoid cavity. The posterior part, broader and stronger, passes from the under and back part of the condyle to the inner border of the olecranon; and the intermediate fibres are connected with a small transverse band, which passes over the notch between the olecranon and the coronoid process.

The **external lateral ligament**, intimately connected with the tendinous attachment of the extensor muscles, is shorter and narrower than the internal. It is attached superiorly to a depression below the external condyle of the humerus, and inferiorly becomes blended with the annular ligament of the radius, some of its hinder fibres being prolonged to the ulna.

Fig. 134.

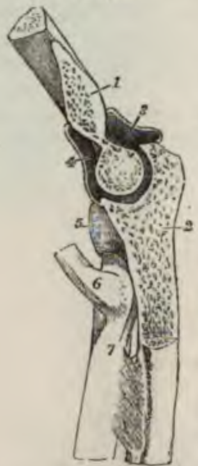


Fig. 134.—SAGITTAL SECTION OF THE ELBOW-JOINT THROUGH THE GREAT SIGMOID CAVITY OF THE ULNA AND THE TROCHLEAR SURFACE OF THE HUMERUS. (A. T.) $\frac{1}{3}$

1, cut surface of the humerus ; 2, that of the ulna ; 3, posterior part, and 4, anterior part of the synovial cavity of the joint ; 5, orbicular ligament ; 6, tendon of the biceps muscle ; 7, is at the lower end of the oblique ligament.

The **anterior ligament** consists of a thin sheet of fibres, strongest in its middle part, extending downwards from above the coronoid fossa of the humerus to the coronoid process of the ulna and the orbicular ligament.

The **posterior ligament** is comparatively thin and weak, and consists of loose and irregular fibres passing transversely across the olecranon fossa of the humerus, and from the sides of that fossa to the olecranon process, thus completing the capsule of the joint behind.

The **synovial membrane** extends upwards on the humerus so far as to line the fossæ for the coronoid and olecranon processes, and is loose and vascular in the latter positions. It is also prolonged round the neck of the radius, and lines the annular ligament.

**Movements.**—Flexion and extension are the only movements which take place between the humerus and ulna; and in the perfect limb these are arrested, flexion by the meeting of the soft parts of the arm and forearm, extension by the tightening of the ligaments and muscles on the front of the joint, before the coronoid and olecranon processes meet the bottom of their respective fossæ on the humerus. The path of motion is in a nearly vertical plane, with a direction slightly outwards in extension. The inner lip of the trochlea being prominent below, forms an expansion which corresponds to an inward projection of the coronoid part of the ulnar surface; while the outer lip of the trochlea, being enlarged at the upper and back part, forms a surface which is only in use in complete extension, and which then corresponds to a surface on the outer aspect of the olecranon, which comes into contact with no other part of the humerus. In flexion and extension the radius moves by its cup-shaped head upon the capitellum, and on the groove between that process and the trochlea by a ridge internal to the cup. It is most completely in contact with the humerus in the position of semi-flexion and semi-pronation.

### THE WRIST-JOINT AND ARTICULATIONS OF THE HAND.

THE RADIO-CARPAL ARTICULATION, or wrist-joint, is formed between the radius and triangular fibro-cartilage above, and the scaphoid, semilunar and pyramidal bones below. The superior surface is concave both transversely and from before backwards; the inferior surface is correspondingly convex, and is prolonged farther down upon the carpal bones behind than in front. The articular surface of the radius is subdivided into two parts by a linear elevation; an outer, triangular, for the scaphoid, and an inner, quadrilateral, which together with the triangular fibro-cartilage, corresponds to the semilunar bone. The small articular surface of the pyramidal is in most cases in contact with the fibro-cartilage only when the hand is adducted.

The **internal lateral ligament** is a rounded cord passing directly downwards from the styloid process of the ulna, to the pyramidal bone, and by its anterior fibres to the pisiform bone.

The **external lateral ligament** extends from the styloid process of the radius to a depression on the scaphoid bone between the radial articular surface and the tubercle.

Fig. 135.

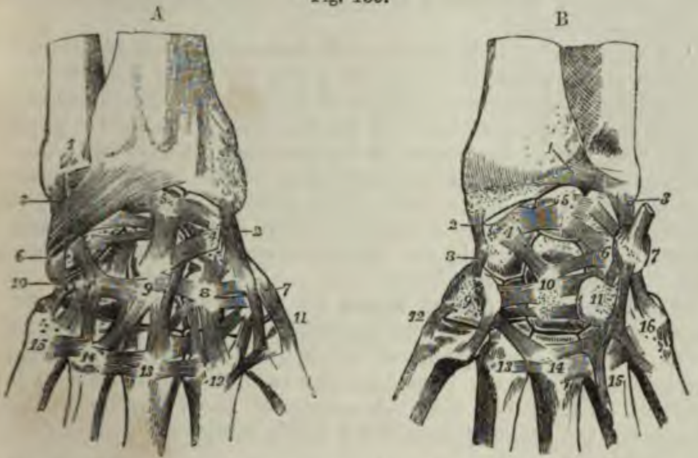


Fig. 135, A.—DORSAL VIEW OF THE LIGAMENTS OF THE WRIST-JOINT, AND OF THE CARPAL AND CARPO-METACARPAL ARTICULATIONS. (A. T., after Arnold.) $\frac{1}{2}$

1, lower part of the ulna ; 2, external lateral ligament of the wrist-joint ; 3, internal ; near it descending obliquely to 6, from the radius, the dorsal radio-carpal ligament ; 4 to 5, dorsal ligaments of the first row ; 4, is on the scaphoid ; 5, on the semilunar bone ; 6, pyramidal bone, with the attachment of the dorsal radio-carpal ligament ; 7, trapezium ; 8, trapezoid ; 9, os magnum ; 10, unciform ; 11 to 15, metacarpal bones ; 7 to 8, 8 to 9, and 9 to 10, dorsal ligaments of the second row of carpal bones ; 4 to 8, 4 to 9, 5 to 9, and others, dorsal ligaments between the first and second row ; 8 to 12, 9 to 13, and others, dorsal ligaments from the second row to the metacarpal bones ; between the metacarpal bones, from 11 to 15, the dorsal intermetacarpal ligaments.

Fig. 135, B.—PALMAR VIEW OF THE LIGAMENTS OF THE WRIST-JOINT, AND OF THE CARPAL AND CARPO-METACARPAL ARTICULATIONS. (A. T.) $\frac{1}{2}$

The anterior radio-carpal ligament has been removed : 1, anterior ligament of the lower radio-ulnar articulation ; 2, external, and 3, internal lateral ligament of the wrist-joint ; 4, scaphoid bone ; 5, semilunar ; 6, pyramidal ; 7, pisiform, with the tendon of flexor carpi ulnaris attached ; 4 to 5, and 5 to 6, palmar ligaments of the first row ; 8, external lateral ligament between the first and second row of carpal bones ; 9, trapezium (the trapezoid is not numbered) ; 10, os magnum ; 11, hooked process of the unciform bone ; 9 to 10, 10 to 11, and others, palmar ligaments of the second row ; 4 to 10, and 6 to 10, some of the palmar ligaments uniting the two rows, converging on the os magnum ; 7 to 11, ligament from the pisiform bone to the unciform process ; 7 to 16, ligament from the pisiform to the fifth metacarpal bone ; 12, external ligament of the first carpo-metacarpal articulation ; 13, 14, 15, 16, the proximal ends of the second to the fifth metacarpal bones, on which the palmar transverse, and on three of them, a set of piso-metacarpal ligaments are shown.

The **anterior ligament**, broad and membranous, consists partly of fibres which have a nearly transverse direction, partly of others which diverge as they descend from the anterior border of the radius to the scaphoid, semilunar, and pyramidal bones ; some of them are continued to the os magnum. On the inner side a strong bundle springs from the root of the styloid process of the ulna and passes to the pyramidal and semilunar bones.

The **posterior ligament** extends obliquely downwards and inwards, from the extremity of the radius to the posterior surface of the first row of the carpal bones, especially the pyramidal bone; its fibres are prolonged some distance on the surface of the carpal bones.

The **synovial membrane** is simple and lines the ligaments between the articular surfaces.

THE CARPAL ARTICULATIONS.—The bones of the carpus, the pisiform excepted, are so arranged in two rows, that while only slight movement can take place between the members of each row, a considerable amount of movement is possible between the two rows. The surface presented by the first row to the second is concave both transversely and from before backwards in the greater part of its extent, but at its outer side it is formed by the convex part of the scaphoid bone. The opposing surface of the second row is concavo-convex from without inwards, the concavity being formed by the trapezium and trapezoid, the convexity by the os magnum and unciform bone.

The **two rows of carpal bones** are united by dorsal, palmar, and lateral ligaments. The *lateral ligaments* are placed one at the radial, the other at the ulnar border of the carpus; the former connects the scaphoid bone with the trapezium, the latter the pyramidal with the unciform. The *dorsal ligaments* consist of fibres passing in various directions; the *palmar ligaments* are chiefly composed of fibres converging towards the os magnum.

The **bones of the first row**, the pisiform bone excepted, are united by interosseous and by dorsal and palmar ligaments. The *interosseous ligaments*, placed on the sides of the semilunar bone on a level with its superior surface, connect it with the scaphoid and pyramidal bones, thus completing the inferior wall of the radio-carpal joint. The *dorsal* and *palmar ligaments* extend transversely on the dorsal and palmar surfaces from the scaphoid bone to the semilunar, and from the semilunar to the pyramidal.

The **bones of the second row** are connected by similar means. The *dorsal* and *palmar ligaments* pass transversely between the contiguous bones. The *interosseous ligaments* are generally three (but sometimes only two) in number, a strong ligament being placed between the os magnum and unciform bones, another between the trapezoid and trapezium, and a slender ligament between the os magnum and trapezoid. A small interosseous ligament is also found sometimes between the os magnum and the scaphoid. (Fig. 136.)

The **synovial cavity** of the carpal articulations is extensive and complicated. Passing between the two rows of carpal bones, it sends upwards two processes between the three bones of the first row, and downwards three between the four bones of the second row. It is farther continued below into the inner four carpo-metacarpal and three intermetacarpal articulations. In some rare cases there is continuity with the synovial cavity of the wrist-joint, by deficiency of one of the interosseous ligaments between the upper carpal bones.

The **pisiform bone** is articulated by a thin fibrous capsule and synovial membrane with the pyramidal bone. Inferiorly it is united by two strong ligaments with the unciform and fifth metacarpal bones, and is sometimes also connected with other metacarpal bones; superiorly it receives the tendon of the flexor carpi ulnaris muscle. The synovial cavity is usually distinct, but sometimes communicates with that of the radio-carpal articulation.

Fig. 136.

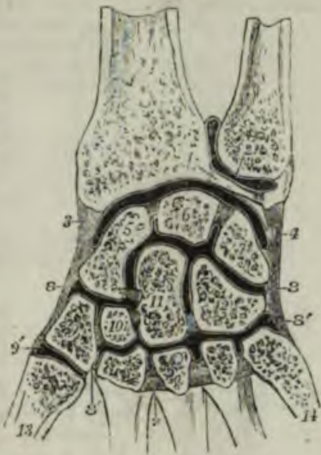


Fig. 136.—FRONTAL SECTION OF THE INFERIOR RADIO-ULNAR, RADIO-CARPAL, INTERCARPAL, AND CARPO-METACARPAL ARTICULATIONS. (A. T.) ½

1, points to the triangular fibro-cartilage below the ulna; 2, placed on the ulna, points to the cavity of the sacciform synovial membrane; 3, external lateral, and 4, internal lateral ligament, and between them the synovial cavity of the wrist; 5, scaphoid bone; 6, semilunar; 7, pyramidal; 8, 8, upper portion, and 8′, 8′, lower portion of the general synovial cavity of the intercarpal and carpo-metacarpal articulations; between 5 and 6, and 6 and 7, the interosseous ligaments are seen separating the carpal articular cavity from the wrist-joint; between the four carpal bones of the lower row, and between the magnum and scaphoid, the interosseous ligaments are also shown; the upper division of the synovial cavity communicates with the lower between 10 and 11, and between 11 and 12; ×, marks one of the three interosseous metacarpal ligaments; 9′, separate synovial cavity of the first carpo-metacarpal articulation; 13, first, and 14, fifth metacarpal bone.

NOTE.—It is to be observed that in this figure, and in others of a like kind which represent the joint-cavities, the white or black lines indicating the synovial membranes are, for the sake of clearness, generally represented as passing over the surfaces of the articular cartilages, although this is not the case in nature. These lines therefore must be held to represent merely the whole continuity of the articular or, as they are often called, the synovial surfaces.

The **anterior annular ligament** of the wrist is a strong and thick band, which extends from the prominences made by the trapezium and scaphoid bone on the radial side of the carpus, directly across to the pisiform bone and unciform process, and converts the transverse arch of the carpus into a ring through which the flexor tendons of the digits pass into the hand.

The **posterior annular ligament**, placed at the back of the wrist, is only a thickened part of the aponeurosis of the forearm. It extends from the lower part of the radius, at its outer border, to the inner part of the pyramidal and pisiform bones and serves to bind down the extensor tendons.

### CARPO-METACARPAL AND INTERMETACARPAL ARTICULATIONS.

The **four inner metacarpal bones** are bound together at their distal extremities by fibres passing between the palmar ligaments of the metacarpo-phalangeal articulations, and constituting the *transverse metacarpal ligament.* At their proximal extremities they are united to one another and to the carpal bones in articulations, the common synovial lining of which is derived from that of the intercarpal joint. In these articulations the four metacarpal bones are bound together by three *dorsal,* and three *palmar,* and by strong *interosseous ligaments.* The second, third and fourth metacarpal bones are united to the carpus by *dorsal ligaments*, of which each bone receives two, viz., the second from the trapezium and trapezoid, the third from the trapezoid and os magnum, and the fourth from the os magnum and unciform, and by *palmar ligaments*, one to each bone, but which are not so well defined and less constant. The fifth metacarpal bone is united to the unciform bone by a thin capsule which surrounds the articulation except on the outer side. There is likewise an *interosseous* band in one part of the carpo-metacarpal articulation, connecting the lower and contiguous angles of the os magnum and unciform to the adjacent angle of the third metacarpal bone. This ligament sometimes separates the cavity between the unciform and two inner metacarpal bones from the rest of the joint.

Fig. 137.

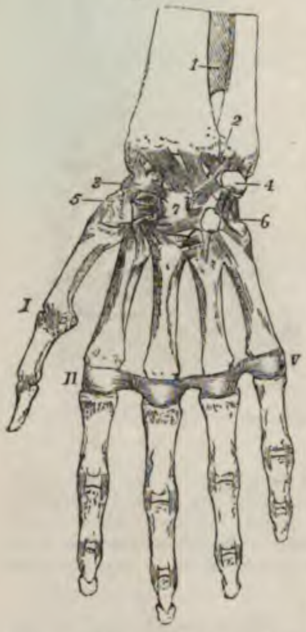


Fig. 137.—General view of the articulations of the wrist and hand from before. ½

1, lower part of the interosseous membrane; 2, and from that point across the lower end of the radius, the palmar radio-carpal ligaments; 3, scaphoid bone; 4, pisiform; 5, trapezium; 6, unciform; 7, os magnum, with most of the deeper ligaments uniting these bones; I, first metacarpo-phalangeal articulation with its external lateral ligament; II to V, transverse metacarpal ligament: in the several interphalangeal articulations of the fingers the lateral ligaments are shown; in the thumb the external only is visible.

The **first metacarpal bone** is articulated with the trapezium by a capsular investment, which is thickened behind and on the outer side, and is lined by a distinct synovial membrane.

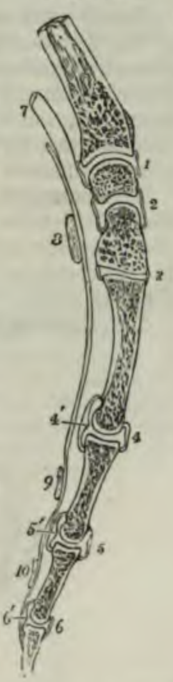
### METACARPO-PHALANGEAL AND INTERPHALANGEAL ARTICULATIONS.

The rounded head of each metacarpal bone is received into the slight hollow in the base of the first phalanx, and the bones are maintained in position by two lateral ligaments and an anterior ligament.

The **lateral ligaments** are strong bands springing from the tubercle and depression on each side of the head of the metacarpal bone, and passing downwards and forwards to the contiguous margin of the phalanx. The anterior fibres are directed almost horizontally forwards and join the palmar ligament of the articulation.

The **anterior** or **palmar ligament,** or rather **fibrous plate,** occupies the interval between the lateral ligaments on the palmar aspect of each joint; it is a thick and dense fibrous structure, which is firmly united to the phalanx but loosely adherent to the metacarpal bone. It is continuous at each side with the lateral ligament, so that the three form one undivided structure which covers the joint, except on the dorsal aspect. Its palmar surface is grooved for the flexor tendon, the sheath of which is connected to it at each side; the other surface, looking to r of the joint, is lined by synovial membrane, and supports f the metacarpal bone. In the joint of the thumb there are id bones, one situated at each side, which are connected with its.

Fig. 138.



ACITTAL SECTION THROUGH THE LOWER PART OF S, SEMILUNAR BONE, OS MAGNUM, METACARPAL BONE ANGES OF THE MIDDLE FINGER, TO SHOW THE SHAPE RTICULAR SURFACES AND THE SYNOVIAL CAVITIES THESE SEVERAL BONES. (A. T.) $\frac{1}{3}$

cavity of the wrist-joint ; 2, intercarpal cavity ; tacarpal cavity ; 4, metacarpo-phalangeal cavity ; terphalangeal cavities ; 4′, 5′, and 6′, the palmar s which are attached to the bases of the several , indicates the place of the tendons of the long flexor section of the anterior annular ligament ; 9, and 10, tinacula, or vaginal ligaments of the flexor tendons nd second phalanges.

**vial membrane** is present in each joint, ts the surface of the ligaments which e bones.

*erphalangeal articulations* differ from the only in the shape of the articular surfaces .

**ts of the Wrist and Fingers.**—The move- g place at the wrist have their seat partly in arpal, partly in the intercarpal articulation. he freest movement, but a considerable degree nsion is also permitted. The hand can also be ally, and to a greater extent inwards (adduction ion) than outwards (abduction or radial flexion). movement which is allowed between the several metacarpal bones is best illustrated by placing a such a position that the weight of the body on the open palm. The metacarpal range, which concave towards the palm, is flattened ; and the and palmar metacarpal ligaments are thus tightened, while a slight f the opposed surfaces of the bones takes place ; so also the palmar arpal ligaments are tightened, and both palmar and interosseous f the second range of carpal bones. The convex part of the os d unciform bone, fitted in these circumstances into the concavity of ge, is a little wider than the part usually in contact with it ; and the bones of the first range are separated from the palmar side, those nd range are pressed still more apart from the distal aspect. The gement secures elasticity. The fourth and especially the fifth meta- s are not so tightly bound to the carpus as the second and third, and re be moved to some extent forwards (opposition), thus making the wer and deepening the hollow of the palm : these bones move in this stinctly in shutting the hand, so that the back is then rendered more l the tips of the fingers are brought more closely together. At the geal articulations the only movements allowed are flexion and while over-extension is prevented by the ligamentous structures in e joints. At the metacarpo-phalangeal articulations of the fingers nd adduction are allowed, chiefly in the extended position. In the of the metacarpal bone of the thumb with the trapezium all kinds of vement are allowed, but owing to the shape of the articular surfaces nt of flexion is accompanied by a certain amount of rotation of the bone on its long axis, by which the thumb is turned towards the fingers, thus giving rise to the so-called opposition. The metacarpo-phalangeal articulation of the thumb allows of only a limited amount of flexion and extension.

## ARTICULATIONS OF THE PELVIS.

Articulation of the Pelvis with the last Lumbar Vertebra.—The fifth lumbar is united to the first sacral vertebra by anterior and posterior ligaments of the bodies, capsular ligaments of the articular processes, ligamenta subflava of the arches, interspinous and supraspinous ligaments, and by an intervertebral disc, all of which are similar to those between the vertebræ above. It is also attached to the pelvis by two other ligaments, as follows.

The **sacro-vertebral ligament** is a variable fasciculus, passing from the lower border of the transverse process of the last lumbar vertebra obliquely downwards to the lateral part of the base of the sacrum; its fibres diverge as they descend, and some of them join the anterior sacro-iliac ligament.

The **ilio-lumbar ligament** is a strong band extended horizontally

Fig. 139.

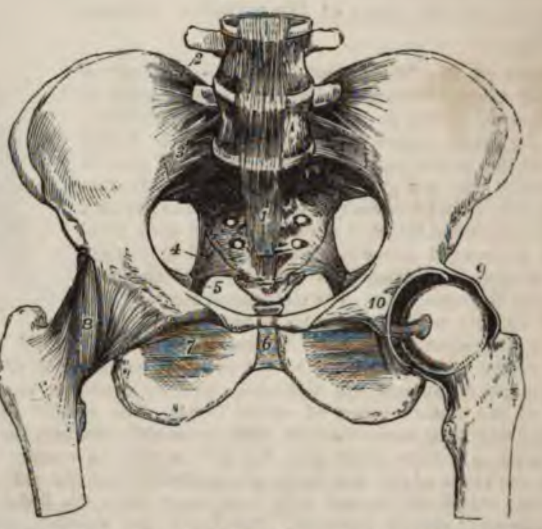


Fig. 139.—Articulations of the pelvis and hip-joint, seen from before. The anterior half of the capsular ligament of the left hip-joint has been removed, and the femur rotated outwards. (A. T.) $\frac{1}{4}$

1, 1, anterior common ligament of the vertebræ passing down to the front of the sacrum; 2, ilio-lumbar ligament; 3, anterior sacro-iliac ligament; between 2 and 3, on the right side, the sacro-vertebral ligament is shown, but not with sufficient distinctness; 4, placed in the great sacro-sciatic foramen, points to the small sacro-sciatic ligament; 5, a portion of the great sacro-sciatic ligament; 6, anterior ligament of the symphysis pubis; 7, obturator membrane; 8, capsular ligament of hip-joint: the figure is placed on its ilio-femoral band; 9, upper part of the divided capsular ligament of the left hip-joint near the place of its attachment to the border of the acetabulum; 10, placed on the os pubis of the left side above the transverse ligament of the acetabular notch. The head of the femur is withdrawn partially from the socket, so as to show the interarticular ligament stretched from the transverse ligament.

thinner than the preceding, in front of which it lies, is also triangular in form, and is attached by its base to the side of the sacrum and coccyx, where its fibres are blended with those of the great ligament; and by its apex to the spine of the ischium. The deep surface of this ligament is blended with the coccygeus muscle.

**Foramina.** Between the upper border of the great sacro-sciatic ligament and the innominate bone, is a large space subdivided by the small sacro-sciatic ligament. The part which lies above this ligament is named the *great sacro-sciatic foramen.* It transmits the pyriformis muscle and the gluteal, sciatic, and pudic vessels and nerves. The part between the greater and lesser sacro-sciatic ligaments, much smaller and bounded in front by the smooth surface between the spine and tuberosity of the ischium, is the *small sacro-sciatic foramen*, through which pass the obturator internus muscle and the pudic vessels and nerve.

The **pubic articulation,** or *symphysis pubis*, is the connection of the pubic bones in front, and is effected by an interpubic disc and ligaments. The *interpubic disc* consists of a layer of cartilage on each side, closely adherent to the bony surfaces, and an intermediate stratum of fibrous tissue and fibro-cartilage. The intermediate layer is thicker in front than behind, and generally contains a fissure towards the upper and back part, which sometimes extends through the whole depth of the articulation. The ligaments are named *anterior*, *posterior*, *superior*, and *inferior*. The anterior pubic ligament consists of irregular fibres passing obliquely across from bone to bone in front of the symphysis. The superior and posterior ligaments consist of only a few fibres on the upper and back parts of the articulation. The inferior or *subpubic* ligament, thick and triangular, is attached to the rami of the pubic bones, giving smoothness and roundness to the subpubic angle, and forming part of the outlet of the pelvis.

The fissure in the interpubic disc appears to be formed during life by the softening and absorption of the fibro-cartilage. It is not found before the seventh year, it increases in extent with advancing age, and is more constant and of larger size in the female than in the male (Aeby). Its greater development in the female sex may be in part due to the pressure exerted upon the joints of the pelvis during parturition, but it is not a regular accompaniment or a direct consequence of pregnancy.

The **obturator membrane,** or *ligament*, is a fibrous septum attached to the border of the thyroid foramen, which it closes, except at the upper and outer part of its circumference, where a small oval canal is left for the obturator vessels and nerve. The membrane is fixed accurately to the bony margin at the upper and outer sides of the foramen, and to the posterior surface at the inner side. The obturator muscles are attached to its surfaces.

**Movements.**—In ordinary circumstances there is very little movement allowed between the bones of the pelvis. In the erect posture the sacrum is thrown so much backwards that none of the advantage of the key-stone of an arch is obtained by the tapering of its form from base to apex. It is only by the sinuosities of its auricular surfaces that it directly presses on the hip-bones; and as the width of the bone rather diminishes at the upper part, the principal strain is borne by the posterior sacro-iliac ligaments, from which the sacrum is in great measure suspended (see fig. 142). The space which might be gained by the small amount of movement which is allowed between the bones of the pelvis in the ordinary state is increased during parturition in this way, that the fore part

THE SACRO-ILIAC ARTICULATION is formed between the auricular surfaces of the sacrum and ilium, which are covered each with a layer of cartilage, that on the sacrum being the thicker, and closely applied together, but are not usually directly united. In some cases, however, the two surfaces are connected in part of their extent by fine transverse fibres; whilst on the other hand, it not unfrequently happens, especially in advanced life, that the surfaces become rough and irregular, and are separated by small spaces containing glairy fluid. The bones are united by anterior and posterior sacro-iliac ligaments, and the articulation receives additional support from the great and small sacro-sciatic ligaments.

The **anterior sacro-iliac ligament** consists of thin irregular fibres passing between the sacrum and hip-bone on their iliac and pelvic surfaces.

The **posterior sacro-iliac ligament** consists of a large number of strong irregular fibres extending from the rough space above the auricular surface of the ilium, downwards and inwards to the depressions on the back of the lateral mass of the sacrum. A superficial band, passing nearly vertically downwards from the posterior superior iliac spine to the third and fourth pieces of the sacrum, is distinguished as the *long* or *oblique sacro-iliac ligament.*

THE SACRO-SCIATIC LIGAMENTS.—The **posterior** or **great sacro-sciatic ligament**, broad and triangular, assists in bounding the lower aperture of the pelvis. Its base is attached to the posterior inferior iliac spine and to the side of the sacrum and coccyx; whilst its apex is fixed along the inner margin of the ischial tuberosity, where it expands somewhat, and sends forwards along the margin of the ischial ramus a *falciform process*, the border of which is continuous with, and forms the inferior attachment of, the obturator fascia. Some of the superficial fibres of the ligament are continued over the tuberosity into the tendon of the long head of the biceps muscle.

Fig. 141.

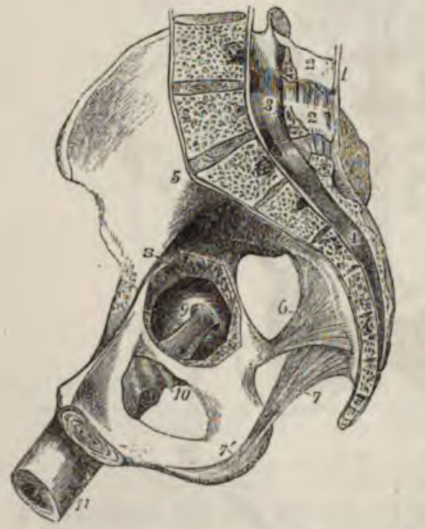


Fig. 141.—RIGHT HALF OF A FEMALE PELVIS, SEEN FROM THE INNER SIDE. (A. T.) $\frac{2}{7}$

1, supraspinous ligament descending to the sacrum from 2, 2, the lumbar spinous processes; 3, 4, lumbar and sacral spinal canal; 5, placed on the ilium above the anterior sacro-iliac ligament; 6, placed in the great sacro-sciatic foramen, points to the small sacro-sciatic ligament; 7, great sacro-sciatic ligament, with 7′, its falciform process; 8, aperture where a portion of the wall of the cotyloid cavity has been removed, so as to give a view from the inside of the head of the femur; 9, interarticular ligament put upon the stretch, the femur being partially flexed and adducted; 10, inner part of the capsular ligament relaxed; 11, shaft of the femur.

The **anterior** or **small sacro-sciatic ligament**, much shorter and thinner than the preceding, in front of which it lies, is also triangular in form, and is attached by its base to the side of the sacrum and coccyx, where its fibres are blended with those of the great ligament; and by its apex to the spine of the ischium. The deep surface of this ligament is blended with the coccygeus muscle.

**Foramina.** Between the upper border of the great sacro-sciatic ligament and the innominate bone, is a large space subdivided by the small sacro-sciatic ligament. The part which lies above this ligament is named the *great sacro-sciatic foramen*. It transmits the pyriformis muscle and the gluteal, sciatic, and pudic vessels and nerves. The part between the greater and lesser sacro-sciatic ligaments, much smaller and bounded in front by the smooth surface between the spine and tuberosity of the ischium, is the *small sacro-sciatic foramen*, through which pass the obturator internus muscle and the pudic vessels and nerve.

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The fissure in the interpubic disc appears to be formed during life by the softening and absorption of the fibro-cartilage. It is not found before the seventh year, it increases in extent with advancing age, and is more constant and of larger size in the female than in the male (Aeby). Its greater development in the female sex may be in part due to the pressure exerted upon the joints of the pelvis during parturition, but it is not a regular accompaniment or a direct consequence of pregnancy.

The **obturator membrane,** or *ligament*, is a fibrous septum attached to the border of the thyroid foramen, which it closes, except at the upper and outer part of its circumference, where a small oval canal is left for the obturator vessels and nerve. The membrane is fixed accurately to the bony margin at the upper and outer sides of the foramen, and to the posterior surface at the inner side. The obturator muscles are attached to its surfaces.

**Movements.**—In ordinary circumstances there is very little movement allowed between the bones of the pelvis. In the erect posture the sacrum is thrown so much backwards that none of the advantage of the key-stone of an arch is obtained by the tapering of its form from base to apex. It is only by the sinuosities of its auricular surfaces that it directly presses on the hip-bones; and as the width of the bone rather diminishes at the upper part, the principal strain is borne by the posterior sacro-iliac ligaments, from which the sacrum is in great measure suspended (see fig. 142). The space which might be gained by the small amount of movement which is allowed between the bones of the pelvis in the ordinary state is increased during parturition in this way, that the fore part of the sacrum being pressed backwards, the wider part of the wedge formed by this bone is forced farther between the hip-bones so as to separate them to a greater degree, and thus to increase the capacity of the pelvis. It is thought also by some that during pregnancy a slight amount of separation may occur at the symphysis pubis from relaxation of the connecting parts. (See Wood, article "Pelvis" in "Cyclopæd. of Anat. and Phys."; Zaglas, in Monthly Journ. of Med. Science, 1851; J. M. Duncan, in Dublin Quart. Journ. of Med. Science, 1854, and Edin. Med. Journ. 1855; Struthers, "Anat. Observ."; Aeby, Zeitsch. f. rat. Med. 1858.)

## ARTICULATIONS OF THE LOWER LIMB.

### THE HIP-JOINT.

This is a ball and socket joint, in which the globular head of the femur is received into the acetabulum or cotyloid cavity of the hip-bone. The articular portion of the acetabulum is a horseshoe-shaped cartilage-covered surface, broader above and behind than in front, and folded round a depression which, extending from the cotyloid notch to the bottom of the cavity, is occupied by adipose tissue covered with synovial membrane, the so-called synovial or Haversian gland. The articular surface of the femur presents a little behind and below its centre a pit in which the interarticular ligament is attached.

The **cotyloid ligament** forms a thick fibro-cartilaginous ring round the margin of the acetabulum, increasing the depth of its cavity, and bridging over the deficiency in its border. Its external surface is in contact with the capsular ligament, the internal closely embraces the head of the femur, and both are covered by the synovial membrane. Its fibres do not run parallel to the circumference of the cotyloid cavity, but pass obliquely from without inwards over its margin, one extremity being attached to the outer, the other to the inner surface.

At the cotyloid notch the fibres of the ligament are continued from side to side, so as to render the circumference complete, and deeper transverse fibres are superadded, from which circumstance, as well as from being stretched across from one margin of the notch to the other, this part is called the *transverse ligament*. Beneath it an interval is left for the admission of the articular vessels.

The **interarticular** or **round ligament** (ligamentum teres) is a variable fasciculus surrounded by synovial membrane, attached by one extremity, which is round, in the fossa on the head of the femur; by the other, which is broad and flat, to the transverse ligament and the margins of the cotyloid notch, the strongest fibres passing to the ischial border. It rests on the fat in the depression of the acetabulum.

The **capsular ligament** surrounding the joint is attached superiorly to the margin of the cotyloid cavity, and inferiorly to the neck of the femur. At its cotyloid attachment the capsule arises, above and behind, from the bony margin outside the attachment of the cotyloid ligament, having its inner surface in close contact with that ligament; in front it arises from the outer aspect of the cotyloid ligament near its base, and at the notch it is similarly attached to the transverse ligament. At its femoral attachment the capsule extends anteriorly to the intertrochanteric line, superiorly to the root of the great trochanter, posteriorly and inferiorly to the junction of the middle and external thirds of the neck. The fibres of which the capsule consists run in two directions, circularly and longitudinally. The circular fibres are most distinct at the lower and posterior part of the capsule, where they are collected into a band about half an inch in breadth, which embraces the neck of the femur; above and in front they spread out and become interwoven with the deeper layers of the strongly developed longitudinal fibres, by which they are thus concealed. The longitudinal fibres on the posterior aspect of the joint are almost absent, being represented only by a few scattered fibres which support the synovial membrane, and attach the circular fibres to the neck of the femur. In other parts of the capsule the longitudinal fibres form thick bands, certain of which from their great size and strength are distinguished as accessory ligaments. The m important of these is formed on the anterior and superior aspects of

Fig. 142.

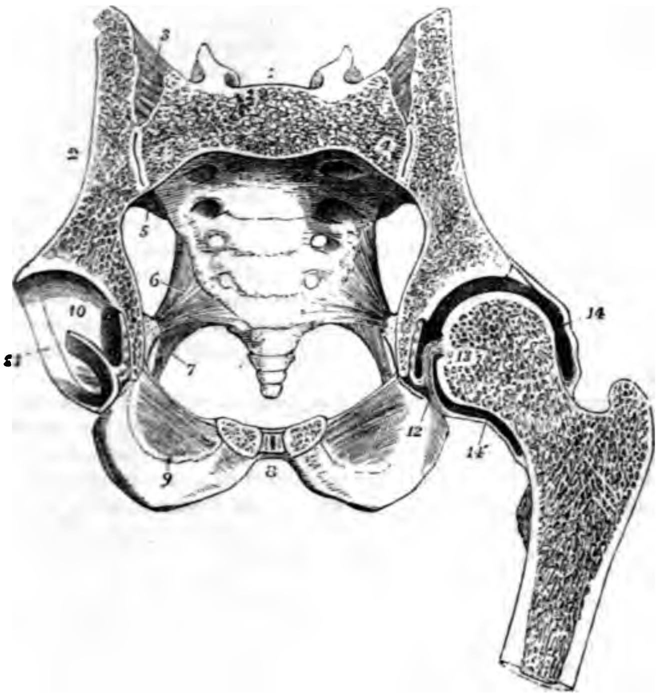

Fig. 142.—TRANSVERSE OBLIQUE SECTION OF THE PELVIS AND HIP-JOINT, CUTTING THE FIRST SACRAL VERTEBRA AND THE SYMPHYSIS PUBIS IN THEIR MIDDLE, FROM A MALE SUBJECT OF ABOUT NINETEEN YEARS OF AGE. (A. T.) ⅓

1, first sacral vertebra; 2, ilium; 3, posterior sacro-iliac ligament; 4, cavity of the sacro-iliac articulation; 5, anterior sacro-iliac ligament; 6, small sacro-sciatic ligament; 7, great sacro-sciatic ligament; 8, placed in front of the symphysis pubis, in the cut surface of which the small median cavity, the adjacent cartilaginous plates, and the anterior and posterior ligamentous fibres are shown; 9, lower part of the obturator membrane; 10, cartilaginous surface of the cotyloid cavity, through the middle of which the incision passes transversely, dividing the interarticular ligament and the fat in the depression; 11, cotyloid ligament; 12, interarticular ligament connected with the transverse part of the cotyloid ligament; 13, placed on the cut surface of the head of the left femur near the depression where the interarticular ligament is attached; 14, 14′, upper and lower parts of the capsular ligament.

capsule and is known as the *ilio-femoral ligament*. This springs above from the lower part of the anterior inferior iliac spine, and behind this from an impression on the bone immediately above the margin of the acetabulum; the fibres diverge and form two strong bands, the inner of which passes almost vertically to the lower part of the anterior intertrochanteric line; the outer to the upper part of the same line and the adjacent part of the neck of the femur. Between the two bands is a thinner part of the capsule; but it not unfrequently happens that the division is not marked, so that the ligament forms one flat triangular band, attached by its base to the whole length of the anterior intertrochanteric line.* At the lower and hinder part of the joint, a broad and strong band of fibres, *ischio-capsular ligament*, passes from the furrow on the ischium below the acetabulum to end in the circular fibres. In front and below may be also found a number of scattered fibrous bundles, which converge to the capsule from the ilio-pectineal eminence, from the margin of the obturator foramen, and from the obturator membrane, constituting the *pubo-femoral ligament*. Besides these the capsule receives above other strengthening bands from the tendon of the posterior head of the rectus femoris, and from the gluteus minimus.

From the inside of the capsule the innermost fibres are reflected upwards from their insertion upon the neck of the femur to the articular cartilage, forming a surface partly level and partly raised into longitudinal folds called *retinacula*.

The **synovial membrane** of the joint is reflected from the neck of the femur to the inner surface of the capsule, thence to the inner surface of the cotyloid ligament and to the pad of fat in the bottom of the acetabulum, from which it is further prolonged as a tubular investment upon the interarticular ligament. It sometimes communicates, through an opening in the anterior wall of the capsule, with a synovial bursa placed beneath the tendon of the ilio-psoas muscle.

**Movements.**—The movements allowed at the hip-joint are flexion, extension, abduction, adduction, circumduction, and rotation. Extension is limited by the anterior fibres of the capsular ligament, and the inner band of the ilio-femoral ligament: flexion is limited only by the contact of the thigh with the abdomen. Abduction is controlled by the pubo-femoral band, and by the lower part of the capsule; adduction by the outer band of the ilio-femoral ligament, and by the upper part of the capsule. Rotation outwards is checked mainly by the outer part of the ilio-femoral ligament, inwards by the ischio-capsular ligament, the hinder part of the capsule, and by the muscles at the back of the joint. The whole extent of this movement is less than the sixth of a circle. The interarticular ligament is put upon the stretch when the hip is partly flexed, and the thigh then adducted, or rotated out, but it is in many cases so slender that it can have very little influence upon the mechanism of the joint. The ilio-femoral ligament is so strong that it is but rarely broken in dislocations of the hip, and advantage is taken of this circumstance in attempting to reduce the displacement by manipulation. The swinging antero-posterior movement of the femur, as in walking or running, is affected by rotation of the head of the bone in the hip-joint. In the erect attitude a vertical line passing through the centre of gravity of the trunk falls behind the centres of rotation in the hip-joints; the pelvis therefore tends to fall backwards by over extension of the hip-joints, but as this is prevented by the tightening of the capsule in front, the trunk is supported upon the thigh-bones in great measure without muscular effort by virtue of this mechanism of the joint.

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* The outer or upper of these bands is sometimes described separately as the *ilio-trochanteric ligament*; and the whole structure is frequently designated by surgeons the Y ligament of Bigelow.

## THE KNEE-JOINT.

The articular surfaces of this complicated joint are the condyles of the femur and the condylar surfaces of the tibia, with interposed fibro-cartilages, the articulating surface of the patella, and the patellar surface of the femur. The action is mainly that of a hinge-joint. The joint is strengthened superficially by fibrous coverings derived from the surrounding tendons and aponeuroses. The ligaments which have received special names are the following.

The **internal lateral ligament**, long and flat, connects the internal tuberosity of the femur with the inner part of the shaft of the tibia, on which it descends to beyond the level of the tubercle: some of the deeper fibres are also inserted into the internal fibro-cartilage and the margin of the inner tuberosity. The tendon of the semimembranosus muscle

Fig. 143.

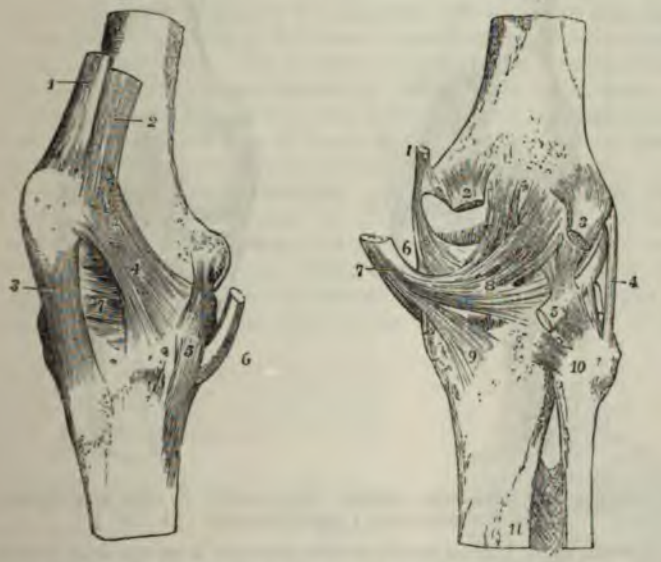


Fig. 143, A.—Right-knee joint, from the inside and anteriorly. (A. T.) ½

1, tendon of the rectus muscle near its insertion into the patella; 2, insertion of the vastus internus into the rectus tendon and side of the patella; 3, ligamentum patellæ descending to the tubercle of the tibia; 4, capsular fibres forming a lateral ligament of the patella prolonged in part from the insertion of the vastus internus downwards towards the inner tuberosity of the tibia: 5, internal lateral ligament; 6, tendon of the semimembranosus muscle. (After Arnold.)

Fig. 143, B.—Right knee-joint from behind. (A. T.)

1, insertion of the tendon of adductor magnus; 2, origin of the inner head of the gastrocnemius muscle; 3, outer head of the same; 4, external lateral ligament; 5, tendon of the popliteus muscle; 6, part of internal lateral ligament; 7, tendon of the semimembranosus muscle; 8, posterior ligament, spreading outward from the tendon; 9, expansion of the popliteal fascia downwards from the same, represented as cut short; 10, on the head of fibula, marks the posterior superior tibio-fibular ligament; 11, upper part of the interosseous membrane with the foramen at the upper end for the anterior tibial artery.

passes to its insertion beneath the posterior border of the ligament, and below the inner tuberosity the lower internal articular vessels are placed between the ligament and the bone.

The **external lateral ligament** is a rounded cord, which extends from the external tuberosity of the femur to the head of the fibula. Its internal surface lies upon the tendon of the popliteus muscle and the inferior external articular vessels. The tendon of the biceps flexor cruris muscle is divided into two by this ligament, and between the ligament and the tendon there is frequently a synovial bursa. Farther back is another less constant band, the *short external lateral ligament*, which springs from the external condyle of the femur in connection with the outer head of the gastrocnemius, and terminates below on the styloid process of the fibula.

Fig. 144.

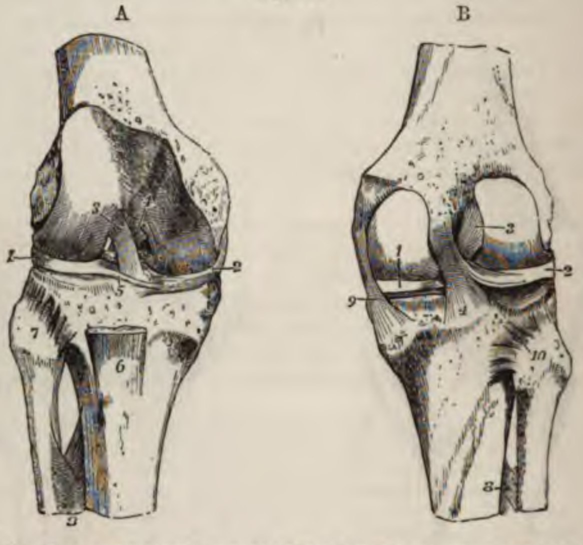


Fig. 144, A.—THE KNEE-JOINT, OPENED FROM BEFORE, TO SHOW THE CRUCIAL LIGAMENTS AND SEMILUNAR FIBRO-CARTILAGES. (A. T.) $\frac{1}{3}$

1, external, and 2, internal semilunar fibro-cartilage ; 3, on the outer condyle of the femur, points to the anterior crucial ligament ; 4, placed on the line separating the patellar surface from the inner condylar surface of the femur, points to the posterior crucial ligament ; 5, transverse ligament of the semilunar fibro-cartilages ; 6, part of the ligamentum patellæ; 7, on the head of the fibula, points to the superior anterior tibio-fibular ligament ; 8, upper part of the interosseous membrane, showing the perforation for the anterior tibial artery.

Fig. 144, B.—THE KNEE-JOINT, OPENED FROM BEHIND, SO AS TO EXPOSE THE CRUCIAL LIGAMENTS AND SEMILUNAR FIBRO-CARTILAGES. (A. T.) $\frac{1}{3}$

1, internal, 2, external semilunar fibro-cartilage ; 3, anterior, 4, posterior crucial ligament : farther up is seen the accessory band from the external semilunar fibro-cartilage ; 8, upper part of the interosseous membrane ; 9, internal lateral ligament ; 10, placed on the head of the fibula, points to the posterior superior tibio-fibular ligament ; between the head of the fibula and the external fibro-cartilage (2) is seen the surface of the tibia, upon which the semilunar cartilage descends in flexion, and where a communication sometimes takes place between the synovial cavities of the knee-joint and of the tibio-fibular articulation.

The **posterior ligament** is broad and membranous, and passes from the upper part of the intercondylar fossa of the femur to the posterior margin of the head of the tibia. It is in great part formed by an expansion from the tendon of the semimembranosus, which is directed upwards and outwards towards the external condyle of the femur, and the outer head of the gastrocnemius muscle.

The **ligamentum patellæ** is a strong flat band, attached superiorly to the apex and lower border of the patella, and inferiorly to the tubercle of the tibia. Between the tibia and the ligament, near its insertion, is placed a synovial bursa. If the patella be considered a sesamoid bone, this ligament must be regarded as part of the tendon of the quadriceps extensor cruris muscle.

The **crucial ligaments**, placed in the centre of the joint, pass from the sides of the intercondylar fossa to the spaces in front of and behind the spine of the tibia. They decussate somewhat like the lines of the letter X. The *anterior* or *external ligament* is fixed by its lower extremity to the inner part of the depression before the spine of the tibia, and by its upper extremity it is inserted into the inner and hinder part of the external condyle of the femur ; hence its direction is upwards, backwards, and outwards. The *posterior* or *internal ligament* is attached inferiorly to the back of the depression behind the tibial spine and superiorly to the lower part of the outer surface of the internal condyle, as well as to the adjacent part of the intercondylar fossa of the femur ; its fibres are directed upwards and a little forwards and inwards.

The **semilunar fibro-cartilages** are two crescent-shaped plates, placed on the articulating surfaces of the head of the tibia, and interposed between these and the condyles of the femur. They have each a smooth free surface above and below, and a convex border, which is thick, while the concave border is thinned to a fine edge, and the part of the articular surface of the tibia within the concave border of each cartilage is left uncovered. At their extremities they are fibrous, and are firmly fixed to the head of the tibia, whilst by the circumference they are connected with the fibrous capsule of the joint.

Fig. 145.

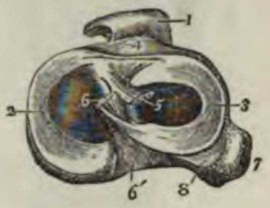


Fig. 145.—VIEW OF THE SEMILUNAR FIBRO-CARTILAGES OF THE RIGHT KNEE-JOINT, FROM ABOVE, WITH THE CRUCIAL LIGAMENTS DIVIDED, AND THE LIGAMENTUM PATELLÆ TURNED FORWARDS. (A. T.) $\frac{1}{3}$

1, ligamentum patellæ ; 2, inner, 3, outer fibro-cartilage ; 4, placed on the tibia in front of the transverse ligament ; 5, cut end of the anterior crucial ligament ; 6, cut end of the posterior crucial ligament, from which fibres are seen descending to the outer fibro-cartilage ; 6′, tibial attachment of the posterior crucial ligament ; 7, head of the fibula ; 8, cartilage-covered surface of the tibia, which extends for some way downwards towards the tibio-fibular articulation.

The **internal semilunar fibro-cartilage** forms about a semicircle ; its anterior extremity is small and pointed, and is inserted into an impression at the fore and inner part of the hollow before the spine of the tibia ; its posterior end is attached to the inner edge of the hollow behind the spine, in front of the posterior crucial ligament.

The **external semilunar fibro-cartilage** forms nearly a complete circle; its two extremities are fixed, one in front of, the other between the points of the spine of the tibia, and are so close at their insertion that they may be said to be interposed between the attachments of the internal semilunar plate. Its external border is in contact behind with the tendon of the popliteus muscle, and is therefore separated by this from the fibrous capsule. From the posterior extremity of this fibro-cartilage a ligamentous band ascends, to be attached to the inner condyle of the femur in connection, either in front or behind, with the posterior crucial ligament.

**Transverse ligament.**—Towards the front of the joint the convex borders of the semilunar fibro-cartilages are connected by a slight transverse band which receives this name. Its thickness varies much in different bodies, and it is sometimes wanting.

**Capsular membrane.**—Under this name is described the fibrous membrane which invests the joint in the intervals between the stronger bands which have been named ligaments. It is incomplete, not extending underneath the tendons of the extensor muscles. Between the sides of the patella and the femur it consists of fibres connected with the insertions of the vasti muscles and with the fascia lata, and thus forms the structures which have been called *lateral patellar ligaments*. Posteriorly it is thin, covering the condyles of the femur beneath the gastrocnemius muscle, and it frequently presents an aperture beneath the inner head of that muscle, through which the bursa under the semimembranosus tendon is put into communication with the joint cavity.

Fig. 146.

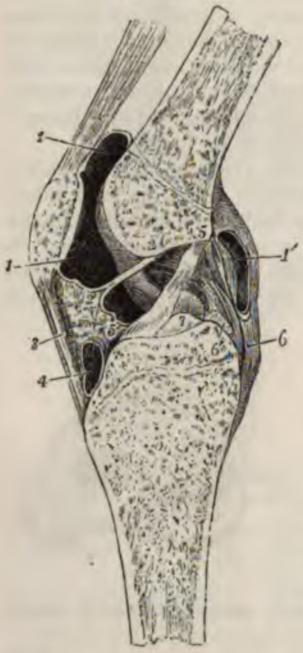


Fig. 146.—SAGITTAL SECTION OF THE LEFT KNEE-JOINT, SEEN FROM THE OUTER OR LEFT SIDE. (A. T.) ⅓

The section is made somewhat obliquely a little to the outside of the middle, so as to preserve entire the crucial ligaments with their attachments: it is from a young subject of eighteen or nineteen years. 1, 1, the upper portion of the synovial cavity extending upwards between the extensor tendon and the femur; 1′, an aperture made into the posterior portion of the synovial cavity; 2, 2′, mucous ligament; 3, ligamentum patellæ; 2, 3, infrapatellar synovial fatty cushion; 4, bursa above the insertion of the ligamentum patellæ into the tubercle of the tibia; 5, 5′, anterior crucial ligament; 5′, points also to the internal semilunar fibro-cartilage within the joint; 6, lower part of the posterior crucial ligament, the upper part of which is towards 2; 6′, the accessory band joining the external semilunar fibro-cartilage, which is cut short; 7, spine of the tibia.

The **synovial membrane** is the largest in the body. Traced downwards from the femur on either side of the joint, it may be followed along the capsule to the upper surfaces of the semilunar fibro-cartilages, round the free borders of those structures to their inferior surfaces, and thence to the tibia. The crucial ligaments are invested in front by a reflected portion of the membrane continued forwards from the posterior wall of the joint. Between the tibia and patella the synovial membrane lies upon a large pad or cushion of fat, on the surface of which it forms two lateral folds (*alar ligaments*) which fit into the space between the lower part of the patella and the femur, while from the middle of the pad it sends backwards a variably developed process, the *mucous ligament*, through the joint to the front of the intercondylar fossa. Above the patella the synovial membrane extends upwards for a short distance under the extensor tendon, and the pouch thus formed communicates in most cases more or less freely with a bursa situated here between the tendon and the anterior surface of the femur.

**Movements, &c.**—In order to explain the nature of the movements, it is necessary to state some considerations with regard to the relations of the several parts of the knee-joint to each other. The knee-joint may be regarded as consisting of three articulations conjoined, viz., that between the patella and femur, and two others, one between each condyle of the femur and the tibia. In many mammals the synovial membranes of those three joints are either completely distinct or communicate with each other by only small openings; and this sometimes occurs in man. In the human subject the mucous ligament is an indication of this separation of the synovial cavities of the inner and outer joints, and the crucial ligaments may be looked upon as the external and internal lateral ligaments of those two joints respectively. On the cartilage-covered articular

Fig. 147.

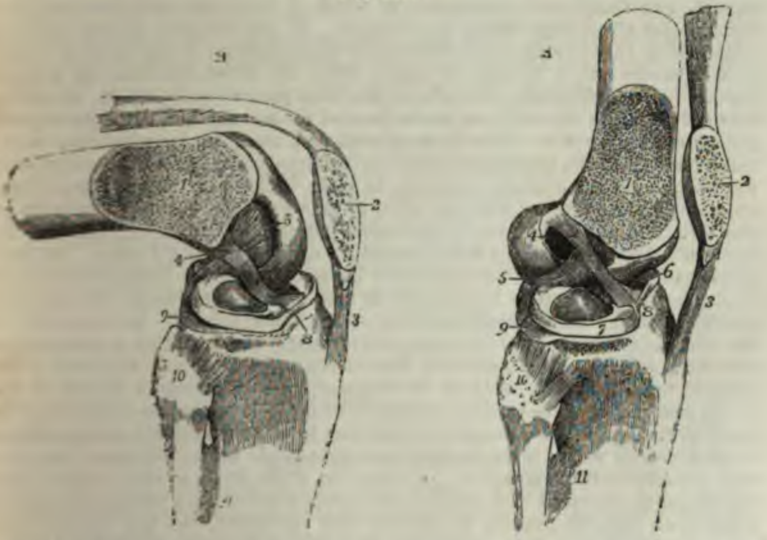


Fig. 147.—THE SUPERFICIAL PARTS OF THE KNEE-JOINT REMOVED, AND THE EXTERNAL CONDYLE OF THE FEMUR SAWN OFF OBLIQUELY, TOGETHER WITH HALF THE PATELLA, SO AS TO EXPOSE BOTH THE CRUCIAL LIGAMENTS TOGETHER. (A. T.) ⅓

In A, the parts are in the position of extension, in B, that of flexion, the figures being designed to show the different states of tension of the crucial ligaments in these positions. 1, sawn surface of femur; 2, sawn surface of patella; 3, ligamentum patellæ; 4, anterior or external crucial ligament, tense in A, and relaxed in B; 5, posterior or internal crucial ligament, partly relaxed in A, tense in B; 6, internal, and 7, external semilunar fibro-cartilage; 8, transverse ligament; 9, articular surface of the tibia, extending behind the external semilunar fibro-cartilage; 10, on the head of the fibula, points to the anterior superior tibio-peroneal ligament; 11, upper part of interosseous membrane.

surface of the femur also a corresponding subdivision into three parts is to be recognised, the trochlear surface for the patella being separated from the convex tibial surfaces by two shallow transverse grooves which receive the fibro-cartilages in the extended position of the joint; but along the inner margin of the intercondylar fossa there is marked off from the rest of the internal condyle a narrow semilunar facet which is common to two of the articulations, being in contact with the spine of the tibia in extension, but with the innermost facet of the patella in extreme flexion.

The movement of the patella on the femur is one partly of gliding, partly of coaptation. This is illustrated by a careful examination of the articular surface of the patella, which is not uniformly curved from above downwards, as it would be, were the movement one of gliding only, but exhibits on each side of the vertical ridge three very slightly depressed surfaces, separated by two slight transverse elevations, and along the inner margin a seventh area, upon which the transverse lines do not encroach (Goodsir.) When the knee is extended, and the patella drawn upwards by the extensor muscles, the two inferior facets of the patella are in contact with the upper margin of the trochlear surface; in semiflexion the middle facets only are in contact with the femur; in greater flexion, the superior parts of the patella are in contact with the lower parts of the trochlear surface; and in extreme flexion the patella, which has been gradually turned outwards by the increasing prominence of the inner condyle, rests by its innermost facet against the narrow surface on the outer margin of the internal condyle, and by its upper and outer facet on the fore part of the external condyle. The articulation between each condyle and the opposed almost flat surface of the tibia, while resembling, is not exactly a hinge-joint, and extension and flexion, the movements of which it is capable, are produced by a combination of gliding, rolling, and rotation. If the condyles of the femur be examined as they rest upon the tibia in the flexed position of the joint, it will be seen that the inner condyle is longer than the outer, and that its anterior portion inclines obliquely outwards, to reach the patellar surface. In the movement of extension the condyles move parallel to one another, both gliding and rolling until extension is nearly completed, and then, the anterior part of the rolling surface of the external condyle having already come into full contact with the tibia, the inner condyle continues to glide backwards, bringing its oblique anterior part into contact with the tibia, so that the bone is rotated inwards on the tibia, and over-extension is prevented, not merely by the tightness of the ligaments, but by the femur being pressed up against the tibial spine. In complete extension the lateral ligaments and the anterior crucial ligament are tight, while the posterior crucial ligament is in part relaxed; in flexion, the posterior crucial ligament only is tightened, the others being relaxed. In extension of the joint no rotation of the leg is possible; in the flexed condition a considerable amount is allowed. The semilunar fibro-cartilages being loosely attached to the head of the tibia, move forwards in extension and backwards in flexion of the joint; and further as the condyles rolling upon the tibia present successively to the condylar surfaces of that bone portions having different curvatures, each cartilage, like a moveable wedge, is contracted round the condyle during flexion of the joint and expanded during extension. In extension of the knee, as the weight of the body keeps the bones in their position, the extensor muscles are relaxed, the patella drops down from its position in contact with the femur, and the mucous ligament then comes into play, supporting the synovial membrane and fat below the patella. As the line of the centre of gravity of the body in the erect attitude descends in front of the axis of motion of the knee-joint, there is a tendency to over-extension of the joint, which is resisted by the tension of the whole of the anterior and part of the posterior crucial, as well as of the posterior and both lateral ligaments, and thus the maintenance of the erect attitude without muscular effort is partly due to the mechanism of the knee-joint. (See H. Meyer, Müller's Archiv, 1853; Goodsir, "Anatomical Memoirs," ii. 220, 231; Langer, Sitzungsber. d. Acad. der Wissensch. Wien, 1858; Henke, Zeitschr. für rat. Med., v. viii., 1859.)

### TIBIO-FIBULAR ARTICULATIONS.

ibia and fibula form articulations at their upper and lower ies, and their shafts are united by an interosseous membrane.

**r tibio-fibular articulation.**—The superior extremities of the resent two flattened oval articular surfaces, retained in close by thin *anterior* and *posterior superior tibio-fibular ligaments,* which pass upwards and inwards from the head of the fibula to rnal tuberosity of the tibia. The synovial cavity of this joint equently communicates posteriorly with that of the knee.

**interosseous membrane** or **ligament,** which connects the the tibia and fibula, passes between the external border of the l the interosseous ridge of the fibula, and is composed for the rt of parallel fibres running outwards and downwards, only a es crossing in a different direction. It presents superiorly an d opening for the transmission of the anterior tibial vessels, and y a small interval is left between it and the lower articulation passage of the anterior peroneal vessels.

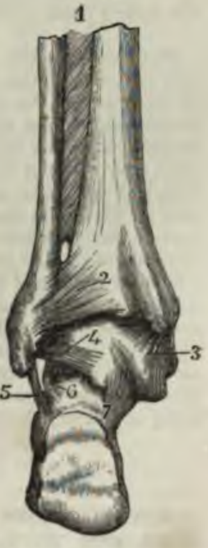
**r tibio-fibular articulation.**—The inferior extremities of the l fibula are in contact by surfaces which for the most part are nd bound together by ligament, but near their lower edges are and covered with cartilage. The tibial surface is concave, the s correspondingly convex. The strong short fibres which pass between the opposed surfaces form the *inferior interosseous liga-* 'he *anterior ligament* (fig. 152, 2) is a flat band of fibres, extended y over the lower part of the bones, the direction of its fibres wnwards from the tibia to the fibula. The *posterior ligament* is disposed behind the articulation. The *se* or *inferior ligament* is a short band of h fibres under cover of the posterior liga- it runs horizontally from the hinder border ower articular surface of the tibia to the ous part of the external malleolus, and closes ilar interval between the bones.

*ynovial cavity* between the small articular is an extension of that of the ankle-joint.

### THE ANKLE-JOINT.

is articulation, which is a hinge-joint, the extremities of the tibia and fibula are o as to present a three-sided hollow, which s the astragalus and renders lateral move- possible when the ligaments are tense.

Fig. 148.



8.—THE LOWER TIBIO-FIBULAR ARTICULATION AND ANKLE-JOINT, FROM BEHIND (A. T.) $\frac{1}{3}$

rosseous membrane; 2, posterior ligament of the o-fibular articulation; 3, internal lateral ligament kle-joint; 4, posterior, and 5, middle bands of the ateral ligament of the ankle-joint; 6, external, and r astragalo-calcaneal ligaments.

**ternal lateral** or **deltoid ligament** (fig. 151, 1) is a flat fasciculus , much broader at the lower than at the upper part. One extremity is attached to the notch on the inferior border of the internal malleolus; the other, to the inner side of the astragalus, the sustentaculum tali of the os calcis, the inferior calcaneo-navicular ligament, and the navicular bone.

The **external lateral ligament** (fig. 152, 4, 5, 6) consists of three distinct bands separated by intervals and disposed in different directions. 1. The *middle* band descends from the extremity of the fibula, to the external surface of the os calcis. 2. The *anterior* band passes obliquely forwards and inwards from the fore part of the outer malleolus to a part of the astragalus in front of its external malleolar surface; it is the shortest of the three. 3. The *posterior* band, the strongest of the three, passes almost horizontally inwards from the pit on the inner side of the malleolus to the posterior surface of the astragalus.

Fig. 149.

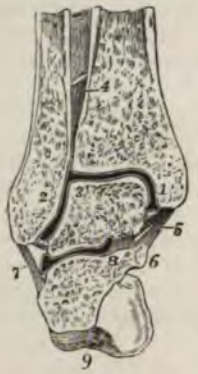


Fig. 149.—Frontal section of the right ankle-joint near its middle, and of the posterior astragalo-calcaneal articulation, so as to show the shape of the articular surfaces and cavities, viewed from before. (A. T.) ⅓

1, internal; 2, external malleolus; 3, placed on the astragalus at the angle between its superior and its external surfaces; 4, inferior interosseous tibio-fibular ligament; 5, internal lateral ligament of the ankle-joint; 6, sustentaculum tali; 7, calcaneo-fibular or middle part of the external lateral ligament; 8, inner part of the interosseous astragalo-calcaneal ligament; 9, tuberosity of the calcaneum.

The **anterior** and **posterior ligaments** are merely scattered fibres in front of and behind the joint; those of the posterior ligament are weak and principally transverse.

The **synovial membrane** of the ankle-joint extends upwards by a small process which lines the lower part of the inferior peroneo-tibial articulation.

**Movements.**—The movements of the ankle-joint are mainly those of flexion and extension of the foot, the directions of those movements being determined by the shape of the articular surfaces. The external border of the superior cartilaginous surface of the astragalus is curved, and longer than the internal border, and hence extension of the ankle-joint is accompanied with a slight inward movement of the fore part of the foot. The horizontal surfaces of both the tibia and astragalus are broader in front than behind; hence in complete extension of the ankle the narrow part of the astragalus is brought into the widest part of the space between the malleoli, and a certain amount of lateral motion is allowed under the influence of external force, whereas in complete flexion, as when the weight of the body, with fully bent knees, is supported on the toes, the broad part of the surface of the astragalus is pushed back into the narrowest part of the space, and the inferior extremity of the fibula is pressed upon, so as to stretch the ligaments between it and the tibia, and thus to prevent lateral movement of the joint, and give it at the same time a certain amount of spring. There appears to be no other movement between the tibia and fibula; these bones being bound together at their lower ends with remarkable firmness.

### ARTICULATIONS OF THE FOOT.

Articulations of the Calcaneum, Astragalus, and Navicular Bone one with another.—The astragalus is connected with the calcaneum by two synovial articulations, viz., by a posterior one peculiar to those two bones, and by an anterior one common to them with the navicular bone. The following are the principal parts requiring description.

**Astragalo-calcaneal ligaments.**—The *interosseous ligament* (fig. 153, 4), broad and strong, passes downwards from the groove between the anterior and posterior articular surfaces of the astragalus to the similar groove between the corresponding articular surfaces of the calcaneum. A membranous *posterior ligament* connects the posterior border of the astragalus with the calcaneum ; its fibres are oblique and very short. There is also an inconstant *external ligament*, consisting of a slight fasciculus of fibres, which descends from the outer surface of the astragalus to the outer side of the calcaneum, parallel with the middle division of the external lateral ligament of the ankle-joint. It may be further observed, that those portions of the lateral ligaments of the ankle-joint which pass down over the astragalus to the os calcis assist in uniting these two bones.

Fig. 150.

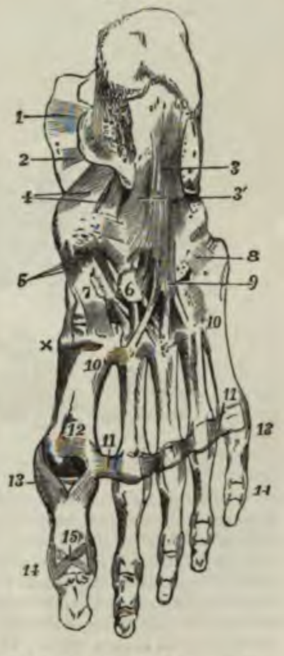


Fig. 150.—LIGAMENTS OF THE FOOT, SEEN FROM BELOW. (A. T.) ⅓

1 and 2, portions of the internal lateral ligament of the ankle-joint ; 3, long plantar ligament ; 3′, short plantar ligament ; 4, inferior calcaneo-navicular ligament ; 5, three naviculo-cuneiform ligaments ; 6, is placed upon the external cuneiform bone, towards which is seen coming from behind a cubo-cuneiform ligament ; 7, is placed upon the internal cuneiform bone ; from 6 and 7, are seen passing forwards the plantar cuneo-metatarsal ligaments ; ×, part of the first dorsal cuneo-metatarsal ligament ; 8, plantar band from cuboid to fifth metatarsal bone ; 9, fibres prolonged from the long plantar ligament, forming the sheath of the peroneus longus tendon ; 10, 10, between these figures the plantar intermetatarsal ligaments ; 11, 11, transverse metatarsal ligament ; 12, intersesamoid ligament ; 13, 13, between these figures are seen the five pairs of internal and external lateral metatarso-phalangeal ligaments ; 14, 14, between these figures are seen the five pairs of internal and external lateral interphalangeal ligaments of the first series ; those of the second series have no figure placed to mark them ; 15, plantar ligament of the interphalangeal articulation of the great toe.

**Calcaneo-navicular ligaments.**— The calcaneum and navicular bones are not in contact, but they are connected by two ligaments. The *inferior* or *plantar ligament*, the larger of the two, is a broad band which passes forwards and inwards from the fore part of the sustentaculum tali to the inferior surface of the navicular bone. It is in contact inferiorly with the tendon of the tibialis posticus muscle, while superiorly it forms the floor of the articular cavity which receives the head of the astragalus, and is lined by synovial membrane. The *external*, *dorsal*, or *interosseous ligament* (fig. 152, 8) forms the external boundary of the cavity just mentioned, and lies deeply at the anterior part of the fossa (sinus pedis), between the astragalus and os calcis. Its fibres, very short, are directed from behind forwards and inwards between the contiguous extremities of the bones. They are attached posteriorly to a ridge of the os calcis that separates the articular surfaces for the astragalus and cuboid, and anteriorly to the outer side of the navicular bone.

The **astragalo-navicular ligament,** a membranous band situated on the dorsum of the foot, extends obliquely forwards from the head of the astragalus to the upper surface of the navicular bone, and completes the capsule of the astragalo-calcaneo-navicular joint, formed in the rest of its extent by the inferior and external calcaneo-navicular ligaments.

Two *synovial membranes* line the articulations of the calcaneum and navicular bone with the astragalus, one belonging to the astragalo-calcaneal joint, and the other to the astragalo-calcaneo-navicular articulation.

Calcaneo-Cuboid Articulation.—The calcaneum is united to the cuboid bone by a synovial joint and ligaments.

The *inferior ligament* consists of two distinct layers, of which one is superficial, the other deep-seated. The superficial part, called the *long plantar ligament* (fig. 150, 3), is the longest of the tarsal ligaments. Its fibres, attached behind to the inferior surface of the calcaneum as far as the anterior tubercle, pass forwards, and are attached in greater part to the ridge on the under surface of the cuboid bone; but some of them are continued onwards to the bases of the third and fourth metatarsal bones, covering the tendon of the peroneus longus muscle. The deep-seated part, or *short plantar ligament* (fig. 150, 3′), lies close to the bones, being separated from the superficial part by some areolar tissue. Its breadth is considerable, its length scarcely an inch. One extremity is attached to the anterior tubercle of the calcaneum, the other, somewhat expanded, to the depressed surface of the cuboid bone behind the ridge.

Fig. 151.

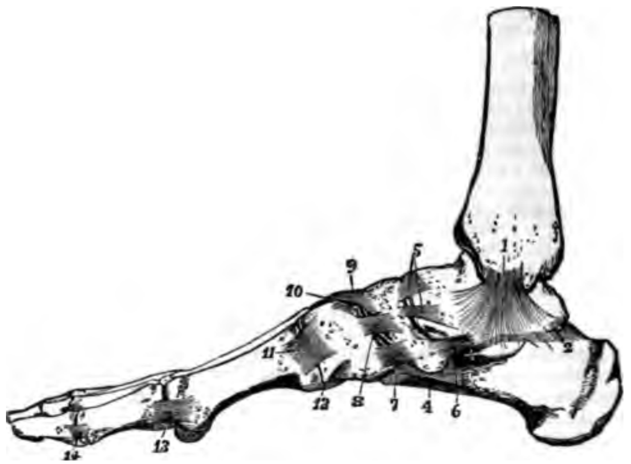


Fig. 151.—Ligaments of the foot, from the inner side. (A. T.) ½

1, internal lateral ligament of the ankle; ×, in front of the sustentaculum tali, showing part of the internal lateral ligament descending upon it; 2, posterior astragalo-calcaneal ligament; 4, part of the long and short plantar ligaments seen from the inside; 5, 6, astragalo-navicular ligament, divided into three portions; 7, 8, first, 9, second dorsal naviculo-cuneiform ligaments; 10, intercuneiform, or transverse dorsal cuneiform, between the first and second cuneiform bones; 11, first dorsal tarso-metatarsal ligament; 12, first inferior tarso-metatarsal; 13, internal lateral metatarso-phalangeal; the internal sesamoid bone is seen below; 14, internal lateral interphalangeal ligament of the first toe.

The *dorsal* or *superior ligament* is a flat band, connecting the upper surfaces of the calcaneum and the cuboid bone.

The *internal* or *interosseous ligament* is placed deeply in the hollow between the astragalus and os calcis, and is closely connected with the external calcaneo-navicular ligament.

A separate *synovial membrane* lines this joint.

ARTICULATIONS OF THE NAVICULAR, CUBOID, AND CUNEIFORM BONES, ONE WITH ANOTHER.—**Naviculo-cuboid Articulation.**—The navicular and cuboid bones are connected by a *dorsal ligament*, composed of short thin fibres, extending obliquely between the two bones; a *plantar*, consisting of transverse fibres; and an *interosseous ligament*, which intervenes between their contiguous surfaces. When the bones touch, which is not always the case, they present two small articulating surfaces, which are covered with cartilage and have between them an offset of the adjacent naviculo-cuneiform synovial cavity.

Fig. 152.

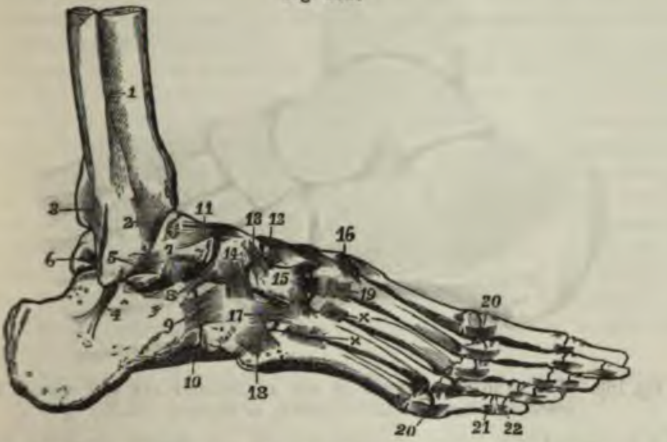


Fig. 152.—LIGAMENTS OF THE FOOT, FROM THE OUTSIDE AND DORSAL ASPECT. (A.T.) ½

1, lower part of the interosseous membrane; 2, anterior inferior tibio-peroneal ligament; 3, posterior inferior tibio-peroneal ligament; 4, middle, 5, anterior, and 6, posterior parts of the external lateral ligament of the ankle-joint; 7, is placed above the interosseous astragalo-calcaneal ligament; 8, external calcaneo-navicular; 9, dorsal calcaneo-cuboid; 10, part of the long plantar *or* calcaneo-cuboid; 11, astragalo-navicular; 12 and 13, second and third naviculo-cuneiform, and between them one of the intercuneiform ligaments; 14, superior naviculo-cuboid; 15, placed on the external cuneiform bone, points to the cuneo-metatarsal ligaments from that bone to the second, third, and fourth metatarsal bones; 16, cuneo-metatarsal ligament, from the first cuneiform to the second metatarsal bone; between 15 and 16, are seen the cuneo-metatarsal ligaments which converge from the three cuneiform bones on the second metatarsal; 17, cubo-metatarsal ligament passing to the fourth metatarsal bone; 18, that to the fifth, 19 and × ×, dorsal intermetatarsal ligaments; 20, lateral metatarso-digital; 21, 22, lateral interphalangeal.

**Naviculo-cuneiform Articulation.**—The navicular articulates with the three cuneiform bones by the smooth facets on its anterior surface, forming one continuous joint. They are united by *dorsal ligaments*, passing from the upper surface of the navicular to the first, second and third cuneiform bones, and by *plantar ligaments*, which are similarly disposed on the under surface of the bones, but these are continuous with, or offsets from, the tendon of the tibialis posticus muscle.

**Cubo-cuneiform Articulation.**—The *cuboid* and the *external cuneiform bones* are connected by a *dorsal ligament*, which is a thin fasciculus of transverse fibres; a *plantar ligament*, whose fibres are also transverse and rather indistinct; and a bundle of *interosseous* fibres. Between the two bones a distinct articulation is formed by cartilaginous surfaces; it is provided sometimes with a separate synovial membrane, at others with an offset from that which belongs to the naviculo-cuneiform articulation.

Fig. 153.

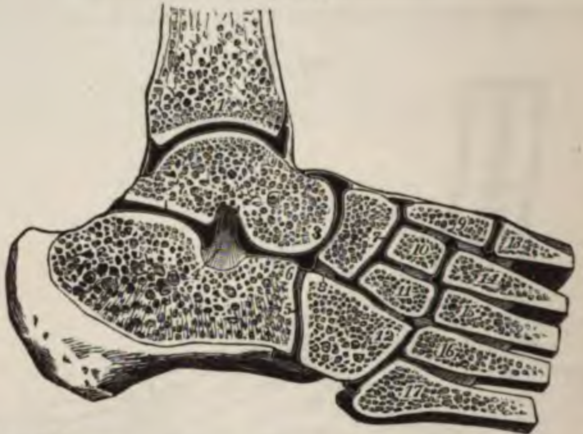


Fig. 153.—THE SYNOVIAL CAVITIES OF THE ANKLE-JOINT AND THE TARSAL AND TARSO-METATARSAL ARTICULATIONS, IN SECTION. (A.T.) ½

The section has been carried obliquely upwards and inwards across the foot, and vertically through the upper part of the astragalus and the tibia. 1, cut surface of the tibia above the ankle-joint; 2, placed on the astragalus above the posterior astragalo-calcaneal synovial cavity; 3, on the head of the astragalus close to the common astragalo-calcaneo-navicular synovial cavity; 4, interosseous astragalo-calcaneal ligament; 5, on the anterior edge of the calcaneum, points to the calcaneo-cuboid synovial cavity; 6, internal calcaneo-cuboid ligament; 7, on the navicular bone, marks the common naviculo-cuneiform and intercuneiform synovial cavity; 8, on the cuboid bone, points to the interosseous naviculo-cuboid ligament; 9, internal, 10, middle, 11, external cuneiform bones; 12, cuboid; between these several bones the interosseous ligaments are shown; from 13 to 17, are the metatarsal bones, with the interosseous ligaments between them; between 9 and 14, the interosseous ligament from the internal cuneiform to the second metatarsal bone: there are also shown in this figure, the synovial cavity of the first tarso-metatarsal articulation, that between the middle and external cuneiform bones and the second and third metatarsal, and that between the cuboid and the fourth and fifth metatarsal bones.

The **three cuneiform bones** are connected by transverse *dorsal ligaments* and strong *interosseous* fibres; the latter being their most efficient uniting structures. The synovial cavity of the naviculo-cuneiform articulation sends forwards two processes between these bones.

ARTICULATIONS OF THE TARSUS WITH THE METATARSUS.—The four anterior bones of the tarsus, viz., the three cuneiform and the cuboid, articulate with the metatarsal bones; and as the first and third cuneiform bones project beyond the middle one, and the third cuneiform beyond the cuboid bone, the anterior surface of the tarsus is very irregular. The first metatarsal bone articulates with the internal cuneiform; the second is wedged in between the first and third cuneiform, and rests against the second; the third metatarsal bone articulates with the extremity of the external cuneiform; and the last two with the cuboid bone, the fourth having also usually an articulation with the external cuneiform. The articulations are synovial joints, and the bones are held in contact by dorsal, plantar, and interosseous ligaments.

The *dorsal tarso-metatarsal ligaments* (fig. 152) are flat thin bands of parallel fibres, which pass from behind forwards, connecting the contiguous extremities of the bones before-mentioned. Thus the first metatarsal bone receives a broad thin band from the corresponding cuneiform bone; the second receives three, which converge to its upper surface, one passing from each cuneiform bone; the third has one from the external cuneiform bone; and, finally, the last two are bound by a fasciculus to each from the cuboid bone, and by fibres from the external cuneiform to the fourth metatarsal bone. The *plantar ligaments* are less regular; the bands of the first and second toes are more strongly marked than the corresponding ligaments on the dorsal surface; and those of the fourth and fifth toes, which are merely a few scattered fibres passing to the cuboid, receive support from the sheath of the peroneus longus tendon. Ligamentous bands stretch in an oblique or transverse direction from the internal cuneiform to the second and third metatarsal bones, and from the external cuneiform to the fifth metatarsal.

The *interosseous ligaments* run forwards between the bones, and from their strength and deep position oppose great resistance to the knife in separating the metatarsus from the tarsus. *a.* The *internal* and largest of these extends from the outer side of the first cuneiform bone to the neighbouring side of the second metatarsal, close to the articular surface. *b.* The *middle*, which is the smallest, and is less constant than the others, passes from the external cuneiform to the outer side of the second metatarsal bone. *c.* The *external* connects the outer side of the external cuneiform to the same side of the third metatarsal bone, and separates the articular cavity of the fourth and fifth metatarsal bones from the rest.

*Synovial cavities.*—There are three synovial cavities in this irregular series of articulations. *a.* One is between the internal cuneiform and the first metatarsal bone; the joint formed between these two bones is altogether separate and out of the range of the rest. *b.* A second synovial cavity is between the cuboid and the fourth and fifth metatarsal bones; this is isolated on the inner side by the external interosseous ligament. *c.* The third or middle one is placed between the middle and external cuneiform and the second and third metatarsal bones, and is prolonged between the two last-named bones, as well as between the third and fourth metatarsal bones. This cavity generally communicates between the internal and middle cuneiform bones with that of the naviculo-cuneiform articulation.

INTERMETATARSAL ARTICULATIONS.—The metatarsal bones are bound together at their tarsal and digital ends; very firmly in the former, and loosely in the latter situation.

The tarsal ends of the four outer bones articulate with each other, having lateral cartilaginous surfaces, between which processes are sent forwards from the two outer synovial cavities of the tarso-metatarsal articulations, and they are connected by dorsal, plantar, and interosseous ligaments. The *dorsal* and *plantar ligaments* are short transverse bands stretching across the four metatarsal bones from one to another. The *interosseous ligaments*, lying deeply between the bones, connect the rough parts of their lateral surfaces; they are of considerable strength and firmness. The first and second metatarsal bones do not usually articulate laterally with each other.

Fig. 154.

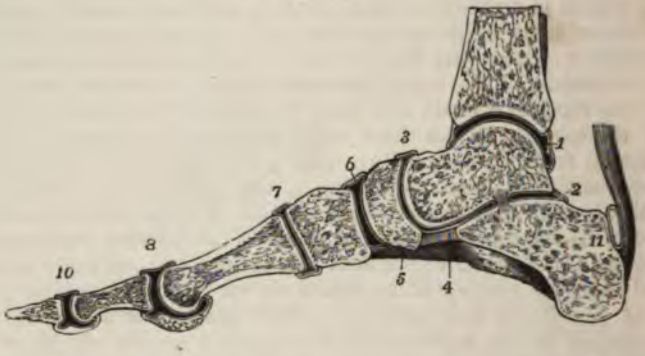


Fig. 154.—SAGITTAL SECTION OF THE ANKLE-JOINT AND ARTICULATIONS OF THE RIGHT FOOT, A LITTLE TO THE INSIDE OF THE MIDDLE OF THE GREAT TOE. (A. T.) ½

1, synovial cavity of the ankle-joint; 2, posterior astragalo-calcaneal articulation; 3, 3′, astragalo-calcaneo-navicular articulation: the interosseous ligament is seen separating 2 from 3′; 4, inferior calcaneo-navicular ligament; 5, part of the long plantar ligament; 6, naviculo-cuneiform articulation; 7, first cuneo-metatarsal articulation; 8, first metatarso-phalangeal articulation; 9, section of the inner sesamoid bone; 10, interphalangeal articulation; 11, placed on the calcaneum, indicates the bursa between the upper part of the tuberosity of that bone and the tendo Achillis.

**Transverse metatarsal ligament.**—The digital extremities or heads of the metatarsal bones are loosely connected by a transverse band, which is identical in its arrangement with the corresponding structure in the hand, with this exception, that it is attached to the great toe, whereas in the hand the transverse metacarpal ligament does not reach the thumb.

METATARSO-PHALANGEAL AND INTERPHALANGEAL ARTICULATIONS.—The heads of the metatarsal bones are connected with the small concave articular surfaces of the first phalanges by two *lateral ligaments*, an *inferior ligament*, which is developed into a thick *fibrous* or *sesamoid plate*, and a synovial membrane,—all being closely similar to the corresponding parts of the hand. In the first metatarso-phalangeal articulation the sesamoid plate is divided into two parts, which are fully ossified, forming the sesamoid bones. These are held together by strong transverse ligamentous fibres, and being provided with cartilaginous surfaces, move upon the corresponding grooved cartilaginous surfaces of the head of the first metatarsal bone.

The articulations of the phalanges with one another are also constructed on the same plan as those of the superior extremity. In each the bones are held in contact by two *lateral ligaments* and an *inferior ligament* or *fibrous plate;* and each of the cavities is lined by a synovial membrane.

**Movements.**—In the mechanism of the foot three arches are distinguishable, two of them longitudinal and one transverse; all of them capable of being flattened somewhat by pressure from above, thus securing elasticity. The inner arch is formed by the os calcis, astragalus, navicular, and three cuneiform bones together with the three inner toes, the astragalus being the key-stone, and is supported especially by the inferior calcaneo-navicular ligament. The outer arch is formed by the os calcis, cuboid bone, and two outer toes, and is supported by the strong inferior calcaneo-cuboid ligaments. Thus the calcaneo-navicular and calcaneo-cuboid ligaments are stretched by the whole weight of the body bearing down upon the arch, and prevent the too great flattening of the instep; an action in which they are assisted, however, by the plantar aponeurosis. The transverse arching of the foot is most marked in the line of the tarso-metatarsal articulations, and is maintained by the wedge-shape of the bones and by the plantar ligaments. The weight of the body, falling upon the balls of the toes when the heel is raised, tends to spread out the metatarsal bones at their distal extremities, and to flatten the transverse arch, which recovers its position when the pressure is removed. Between the astragalus and the calcaneum only one kind of motion is possible, the centre of which is in the interosseous astragalo-calcaneal ligament, and is of such a nature, that when the posterior articular surface of the os calcis glides forwards and downwards beneath the astragalus, the sustentaculum tali moves backwards and upwards, and the cuboid extremity of the bone is carried slightly inwards. The navicular and cuboid bones can be moved downwards and inwards, or upwards and outwards, over the fore part of the astragalus and calcaneum respectively. It is in these articulations mainly that the movements known as *inversion* and *eversion* have their seat. In inversion the fore part of the foot is depressed and carried inwards, the longitudinal arches are increased, and the outer margin of the foot descends more than the inner, so that the sole is turned to some extent inwards. In eversion these actions are reversed, and the foot resumes its normal position. The movement is assisted by a small amount of gliding between the anterior tarsal bones, and between these and the metatarsal bones. Inversion of the foot is always associated with extension, and eversion with flexion of the ankle-joint. The first, and, to a less degree, the fourth and fifth metatarsal bones are capable of a limited amount of movement by which they are carried downwards and towards the middle line of the foot, so that the transverse arch is increased and the fore part of the foot rendered somewhat narrower. The movements of the metatarso-phalangeal and interphalangeal articulations are similar to those of the corresponding joints of the fingers, but are more restricted in their extent.

# MYOLOGY.

## THE MUSCLES IN GENERAL.

UNDER this section will be brought the description of the Voluntary Muscles, and along with it that of the Fasciæ and Aponeuroses by which they are invested.

The voluntary muscles are for the most part placed in close relation with the endoskeleton, being attached to the bones or other hard parts, and moving these in different directions by their contractions. There are, however, some muscles which may be looked upon as belonging to the cutaneous system, or exoskeleton, and there are a few others which are connected with the viscera at the places where these reach the surface of the body. The muscles are all symmetrical, and, with the exception of the sphincters and one or two others, are in pairs.

The number of voluntary muscles to which distinct names have been given in the systems of Albinus and Sœmmering, which are mainly followed in this work, amounts to about 240, there being some variation above or below that number according as certain muscular parts are regarded as separate and independent muscles or only as portions of others. They naturally fall under the following four great divisions, and in the numerical proportions stated under each, viz. :—

A. In the axial part of the body.
  1. The muscles of the head and neck = 75.
  2. The muscles of the vertebral column and trunk = 51.
B. In the limbs.
  3. The muscles of the upper limb = 58.
  4. The muscles of the lower limb = 54.

In the detailed description of the muscles, however, while the foregoing general divisions will be followed, it may be expedient occasionally to deviate from the strictly systematic arrangement, in so far as may conduce to facility in study and convenience in dissection.

Each muscle constitutes a separate organ, composed chiefly of a mass of the contractile fibrous tissue which is called muscular, and of other tissues and parts which may be regarded as accessory. Thus the muscular fibres are connected together in bundles or fasciculi (see General Anatomy), and these fasciculi are again embedded in and united together by a quantity of connective tissue, forming the *perimysium*, and the whole muscle is usually enclosed in an external sheath of the same material. Many of the muscles are connected at their more or less tapering extremities with tendons by which they are attached to the bones or hard parts; and tendinous bands frequently run to a considerable length either on the surface of a muscle or between its fibres. There is indeed great variety in the relation of the muscular and tendinous portions, but few muscles are entirely destitute of some tendinous element in their composition.

Farther, blood-vessels are largely distributed in the substance of a muscle, carrying the materials necessary for its nourishment and chemico-vital changes, and there are also lymphatic vessels, at least in the perimysium and the tendons. Nerves ramify through every muscle, and by means of these the muscular contractions are called forth and a low degree of sensibility is conferred upon the muscular substance.

The muscles vary much in their individual forms. Some are broad and thin, others are more or less elongated straps, and others are cylindrical or fusiform masses of various thickness; hence some of the various names applied to them, such as long and short, square, round, rhomboid, &c. Not unfrequently two or more muscular parts run into one, as in the bicipital, tricipital, or quadricipital forms. In other instances muscles, beginning as single masses, become divided at their remote ends into two or more muscular or tendinous slips. A division of a muscle in its length into two parts by an intermediate tendon gives the form called digastric or biventral, and there are some muscles in which a greater number of parts are thus separated by what have been called tendinous inscriptions.

In the description of the muscles it is customary to state the attachments of their opposite ends under the names of *origin* and *insertion;* the first term being usually applied to the more fixed, or in the case of the limbs the proximal extremity, and the second to the more moveable or remote attachment; but it is to be observed, that it is often difficult to lay down a rule for the correct use of these terms, and that in the great majority of instances it is of importance to consider the action of a muscle as it may affect the motions of the parts attached not to one only but to both of its extremities.

The study of the actions of the muscles either singly or in groups, though strictly a physiological subject, cannot be separated from their anatomical description. With respect to this the following general principles ought to be kept in view. 1st. That the force exerted by any muscle during its contraction is in proportion to the *number* of muscular elements or fibres composing the muscle. 2nd. That the extent of motion, in so far as it merely depends on the shortening of the fibres of the muscle, is in proportion to the *length* of the fibres. And 3rd. That the direction of the force produced by a contracting muscle is in the line of the axis of the whole muscle if it run straight between its opposite points of attachment, but in the line of the portion attached to the moving part if the muscle or its tendon be bent in its course. In most instances of such deflection from the straight course the muscles or their tendons run in loops or in grooves somewhat after the manner of a pulley. The loops are either fibrous or fibro-cartilaginous. In the pulley-like disposition of tendons running over bones, there are frequently fibrous or cartilaginous or bony nodules developed at the place of angular bending of the tendons. The name *sesamoid*, originally given to the small bones developed in some of the digital tendons, has been applied generally to all similar intratendinous structures.

It is further to be observed that the direction in which the muscular fibres or fasciculi run in a muscle is very frequently not that of the axis of the muscle, nor do the muscular fasciculi in the great majority of instances extend from end to end in a muscle. On the contrary, the muscular fibres and fasciculi are much oftener comparatively short, and are attached within the length of the muscle to prolongations of the main tendons or to other tendinous bands which intersect its substance; and thus the muscular fibres run into these tendinous parts with various degrees of obliquity to the axis of the muscle.

The muscular flesh forms a large proportion of the weight of the whole body. This proportion has been carefully determined by Dr. G. v. Liebig (Archiv für Anat. u. Physiol. 1874), from whose tables the following is calculated for a man of 150 lbs. weight: skeleton, 27 lbs.; muscles, 63 lbs.; viscera (with skin, fat, blood, &c.), 60 lbs.

**General Morphology.**—It cannot be doubted that the disposition of the muscles, as a whole and in groups, originally bears a close relation to the plan of vertebrate organization in the skeleton. This is very perceptible in the earlier stages of fœtal development and in the lowest vertebrate animals. In fishes especially, and partly in amphibia, the muscles present a remarkable degree of vertebrate segmentation, the greater part of the muscles of the trunk being subdivided into zones, or *myotomes*, by partitions or *sclerotomes*, partly bony and partly cartilaginous or membranous, which extend transversely through the walls of the trunk, and which correspond in number and position with the vertebral and costal segments. In the higher animals and in man, together with the greater specialization of muscles in connection with the development of limbs, great deviations from the primitive muscular type in the trunk have occurred, and it becomes extremely difficult to trace the morphological relations of the rest of the muscles in the axial part of the body. It is indeed only in the deeper muscles of the vertebral column and of the ribs that the vertebrate subdivision and relation remain in any degree apparent. In the more superficial muscles, and more especially in the muscles of the limbs, where the direction of the fibres is generally outwards from the trunk, portions of the myotomes run together so as to form muscles of greater or less length, in which all appearance of vertebrate division is effaced. In their more general relations also to the trunk of the body two sets of the muscles may be distinguished as *epaxial* and *hypaxial* (episkeletal and hyposkeletal of Huxley), according as they lie above or below the embryonic vertebral axis and the plane of its lateral extension. The *hypaxial* muscles, comparatively little developed in man, comprise chiefly the prevertebral muscles of the neck with the psoas and pyriformis. Of the *epaxial* muscles a *dorso-lateral* division consists mainly of the long and short erector muscles of the spine and head; while a *ventro-lateral* division consists both of such ventral longitudinal muscles as the genio-hyoid, sterno-hyoid, and recti abdominis, and of the lateral, obliquely directed, sterno-mastoid, scalene, intercostal, and abdominal muscles. The muscles of the limbs are also primarily derived from this great ventro-lateral muscle. They may be distinguished as *extrinsic* when attached partly to the limbs and partly to the trunk, and as *intrinsic* when wholly attached to the bones of the limbs and their arches.

To these morphological relations farther reference will hereafter be made under the several large divisions of the muscles. (See Humphry, "Observations in Myology," &c., 1872, and in various papers in the Journ. of Anat.; Huxley, "Anat. of Verteb. Animals," and Mivart, "Lessons in Elementary Anatomy.")

**Homologies and Varieties.**—It follows from what has been stated above, that homologous correspondence can be traced between the individual muscles and groups of muscles of man and those of animals. But as the form and attachments of the muscles are subject to very great variation in different animals, as well as to occasional varieties in the same species, the determination of the special homologies is attended in many cases with great difficulty, and is still very imperfect. Many varieties have also been observed in the human body, and it is interesting to notice that these varieties are found to reappear generally in the same form, or in modifications of it which indicate relations to a typical or fundamental structure; and that many of them are thus more or less repetitions of forms known to exist in different species of the lower animals. (Consult John Wood in Proceedings of Roy. Soc. 1864-8, and Turner and others in Journ. of Anat. & Physiol.; Macalister's Catalogue of Muscular Anomalies, in Trans. Roy. Irish Acad., 1872, and other papers; Hallet, in Edin. Med. Journ., 1845; Wenzel Gruber, in Mem. of the Petersburg Acad.; Henle's Handbuch, Muskellehre, 2nd Ed., 1871; Krause, Handbuch, 3rd Ed. vol. iii. 1880.)

## FASCIÆ.

The term Fascia is applied to parts presenting a membranous disposition of reticulated or felted fibrous tissue. These structures have usually been distinguished as the *superficial* and the *deep;* the former consisting of looser and finer material, and passing by their slenderer kinds into the looser varieties of connective tissue; while the latter, denser in character, frequently exhibit more or less regular arrangements of strong white fibres, giving them a shining appearance, and are often termed *aponeuroses.*

**Superficial Fascia.**—Under this name, or as *subcutaneous fascia,* is described the layer of loose tissue of varying density, which is placed immediately below the skin, all over the body. It is the web which contains the subcutaneous fat, the *panniculus adiposus,* and in some regions superficial muscles, which constitute the *panniculus carnosus.* From the subcutaneous tissue of the eyelids, however, as well as from that of the penis and scrotum, adipose matter is entirely absent. Beneath the fatty layer of the superficial fascia, which is immediately subcutaneous, there is generally another layer of the same structure, comparatively devoid of adipose tissue, in which the trunks of the subcutaneous vessels and nerves are found. When the subcutaneous fat becomes absorbed, the stroma in which it was deposited is still left, and its meshes approach one another, so that in lean subjects a more fibrous condition of the superficial fascia is found than in others.

**Deep Fasciæ and Aponeuroses.**—Under the name of deep fascia is comprehended that stronger layer of fibrous or connective tissue which, lying close to the muscles, invests them, or dips between them, and forms a nearly continuous covering of the body beneath the superficial fascia. It is chiefly to the stronger parts of this fascia that the name of aponeuroses has been given. Those covering the muscles have been named *aponeuroses of investment* (Bichat), to distinguish them from proper tendinous expansions, or *aponeuroses of insertion,* of muscles. This distinction, however, is far from being universally applicable: aponeuroses of insertion are often continued into aponeuroses of investment, as in the instance of the gluteus maximus, or into softer fascia, as at the lateral parts of the occipito-frontal aponeurosis. The principal aponeuroses of investment are those which incase the muscles of the limbs, binding them down in a common sheath, and connected in various places either directly or by septa with the bones. Parts of the deep fasciæ in the vicinity of the larger joints as at the wrist and ankle, become strengthened into tight transverse bands which serve to hold the tendons close to the bones, and hence receive the name of *retinacula* or *annular ligaments.*

**Synovial Sacs and Sheaths: Bursæ Mucosæ.**—In various situations where the tendons of muscles pass over the prominences of bones, or run in fibrous sheaths, synovial cavities exist, either of a vesicular or tubular form, thus forming the *synovial bursæ* or *sheaths*. In many such instances a true synovial membrane appears to cover the adjacent surfaces, and diminishes their friction in moving on each other. In other places less defined spaces exist in the connective tissue between parts of the tendons or fasciæ, and occasionally between parts of the skin and the harder or more prominent structures on which they lie. In some of these subcutaneous bursæ a distinct synovial membrane cannot be found; and there are probably gradations of transition between these bursal spaces and those which are lined by synovial membrane. Some of the synovial sacs and sheaths of tendons in the vicinity of joints communicate freely with the articular cavities. (See Gen. Anat., vol. ii.)

## I.—MUSCLES AND FASCIÆ OF THE UPPER LIMB.

A certain number of muscles situated superficially on the trunk pass to the bones of the shoulder and humerus, so as to attach the upper limb to the body. These muscles, from their position, form a division of the muscles of the trunk, but considered with reference to their destination and action they may be held as belonging to the upper limb, and will therefore be so described in the present section. The muscles referred to are, posteriorly, the trapezius, latissimus dorsi, the rhomboidei, and levator anguli scapulæ; and, anteriorly, the two pectoral muscles, the subclavius, and the serratus magnus. Along with these might also be included the clavicular part of the sterno-cleido-mastoid muscle and the omo-hyoid; but as these last have important relations with parts situated in the neck, they are more conveniently described among the muscles of that region.

### BETWEEN THE TRUNK AND THE UPPER LIMB POSTERIORLY.

FASCIÆ.—The **superficial fascia** covering the muscles which pass from the trunk to the shoulder and upper limb posteriorly forms a layer of considerable strength with embedded fat lying beneath the skin: it is continuous with that of the neck above, that of the axilla and breast in front, and that of the abdomen and hips below.

The **deep fascia of the back** forms a dense fibrous layer closely investing the superficial muscles to which it furnishes sheaths: at the outer margins of the trapezius and latissimus dorsi muscles it is continuous with the deep fasciæ of the neck, axilla, breast, and abdomen, and turns round beneath the edges of the muscles so as to complete their sheaths and separate them from the subjacent layer of muscles. It is attached to the skeleton along the line of the spines of the vertebræ, to the occipital bone, the spine of the scapula, and the crest of the ilium.

In the loins there is a strong, flat, shining tendinous structure called the *lumbar aponeurosis*, to which the latissimus dorsi and other muscles are attached posteriorly; but this will be most conveniently described along with the muscles of the back.

MUSCLES.—The **trapezius** muscle (cucullaris) arises by a thin aponeurosis from the protuberance of the occipital bone, and the inner third of its superior curved line, from the ligamentum nuchæ, and from the spines of the last cervical and all the dorsal vertebræ, as well as from the supraspinous ligament. From this extended line of origin the fibres converge to their insertion: the superior fibres, descending and turning forwards in the neck, are inserted into the outer third of the clavicle at its posterior border; the succeeding fibres pass transversely to the inner border of the acromion process and upper border of the spine of the scapula, while the inferior fibres, ascending obliquely, terminate in a flat tendon which glides over the triangular area at the base of the spine of the scapula, and is inserted into the rough mark near the root of the spine. The greater part of the line of origin presents only a small admixture of tendinous fibres, but opposite the seventh cervical spine, and for the distance of several vertebræ above and below that point, a flat tendon extends outwards, widest at the middle of the space and narrowing towards the upper and lower ends, so that the aponeuroses of the two muscles taken together have an elliptical form. The fibres of origin from the occipital bone have little or no tendinous lustre. The muscles of the two sides have together the form of a four-sided figure, or shawl or cowl, pointing downwards: hence the name of cucullaris which has been given to it.

*Relations.*—The trapezius is superficial in its whole extent: it covers the splenius, the greater part of the complexus appearing above the splenius, the levator anguli scapulæ, the rhomboidei, the supraspinatus, and small portions of the infraspinatus and latissimus dorsi. The spinal accessory nerve and the superficial cervical artery pass into it on its deep surface.

*Varieties.*—The trapezius is subject to considerable variations in its attachments: it is not unfrequently shorter than above described, and the number of dorsal vertebræ with which it is connected is sometimes diminished to six or even fewer. Its occipital attachment may be wanting; and occasionally a separation exists between its cervical and dorsal portions. The insertion into the clavicle is sometimes continued forwards to meet the sterno-mastoid muscle.

The **latissimus dorsi** muscle arises by tendinous fibres from the spinous processes of the lower six or seven dorsal vertebræ, and from the posterior layer of the lumbar aponeurosis, through the medium of which it is attached to the lumbar and sacral spines and back part of the iliac crest; it also arises by short tendinous fibres for an inch or more from the iliac crest in front of the outer margin of the lumbar aponeurosis, and from the last three or four ribs by narrow fleshy slips which interdigitate with the attachments of the external oblique muscle of the abdomen. The fibres at the upper part are the shortest, and pass almost horizontally outwards over the lower angle of the scapula, from which they generally receive a small slip of fleshy fibres; those lower down become longer and pass more obliquely upwards; finally, those which are attached to the ribs ascend almost vertically. By this convergence the fibres of the muscle come to form a narrow band of some thickness, which, accompanying the teres major towards the axilla, winds round the lower and outer border of that muscle so as finally to be placed in front of it. It terminates in a flat tendon of less than an inch and a half in breadth, which is adherent at its lower border to that of the teres major, but is again detached from it previous to its insertion, a synovial bursa intervening between them. The tendon is attached to the floor of the bicipital groove of the humerus, a little higher than the insertion of the teres major. From this twisting of the muscle upon

Fig. 155.

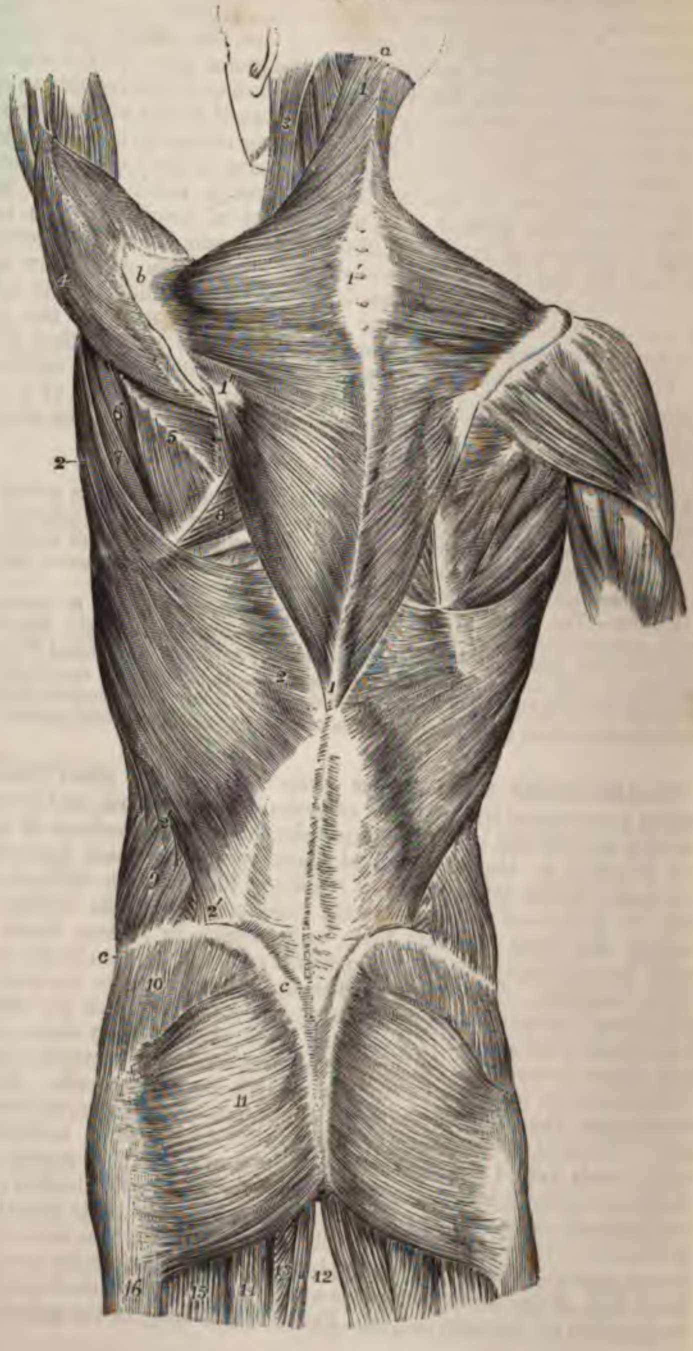


Fig. 155.—SUPERFICIAL MUSCLES OF THE TRUNK, SHOULDER AND HIP, VIEWED FROM BEHIND. (A. T.) ⅛

*a*, external occipital protuberance; *b*, acromion; *c*, crest of the ilium; 1, trapezius; 1′, oval tendon of the two muscles in the upper dorsal and lower cervical region; 1″, triangular tendon of insertion; 2, latissimus dorsi; 2′, 2,′ its costal origins and its origin from the crest of the ilium; 1, 2′, *c*, tendon of latissimus dorsi blended with the posterior layer of the lumbar aponeurosis; 3, sterno-mastoid; 4, deltoid; 5, infraspinatus; 6, teres minor; 7, teres major; 8, rhomboideus major; below this on the left side is seen a triangular space bounded by the rhomboid, trapezius, and latissimus dorsi muscles, in which parts of the sixth and seventh ribs are exposed; 9, back part of the external oblique muscle of the abdomen; between 9 and 2′, a small part of the internal oblique; 10, part of the gluteus medius covered by the fascia lata; 11, gluteus maximus; 12, gracilis; 13, small part of the adductor magnus; 14, semitendinosus; 15, biceps; 16, fascia lata covering the vastus externus.

itself, the anterior surface of the tendon is continuous with the posterior surface of the rest of the muscle.

*Relations.*—The latissimus dorsi is subcutaneous, except at its origin from the dorsal vertebræ, where it is covered by the trapezius, and at its insertion, where it is crossed by the axillary vessels and the nerves of the brachial plexus. It rests on part of the rhomboideus major and infraspinatus, on the teres major, serratus posticus inferior, vertebral aponeurosis, external intercostal muscles, and the posterior borders of the external and internal oblique muscles.

Between the adjacent borders of the latissimus dorsi, trapezius, and rhomboideus major, there is left, when the scapula is drawn forwards, a triangular area in which a portion of one or two ribs and of an intercostal space becomes superficial; this is taken advantage of for the purpose of auscultation.

*Varieties.*—The number of dorsal vertebræ to which the latissimus dorsi is attached varies from four to seven or eight, and the number of the costal attachments is also inconstant, being frequently diminished and more rarely increased. Muscular bands (*axillary arches*) are sometimes seen to pass from this muscle near its insertion across the great vessels and nerves to the fore part of the axilla, where they terminate variously, in the tendon of the greater pectoral, in the coraco-brachialis muscle, the biceps, or in the fascia. From the lower border of the tendon a muscular slip is occasionally given downwards to the long head of the triceps, to the fascia, or to the internal intermuscular septum of the arm, corresponding to the *dorso-epitrochlearis* muscle of apes and many other mammals.

The **rhomboideus minor**, a comparatively narrow muscle, arises from the spinous processes of the seventh cervical and first dorsal vertebræ and from the ligamentum nuchæ. It inclines downwards and outwards, and is inserted into the base of the scapula opposite the triangular surface at the commencement of the spine.

The **rhomboideus major**, much broader than the preceding muscle, lies immediately below and in contact with it. It arises from the spinous processes of the four or five upper dorsal vertebræ and the supraspinous ligament, and is inserted into that part of the base of the scapula which is included between the spine and inferior angle. A considerable part of the attachment at the insertion is only by firm connective tissue, and the greater portion of the fibres, instead of being fixed directly to the bone, end in a tendon which is connected to the scapula near the lower angle; in consequence of this arrangement, the muscle may in part be separated from the bone without division of its muscular or tendinous fibres, and must therefore act most immediately on the lower angle.

*Relations.*—The greater part of the rhomboidei muscles is covered by the trapezius, a small angular portion only of the rhomboideus major being sub-

Fig. 156.

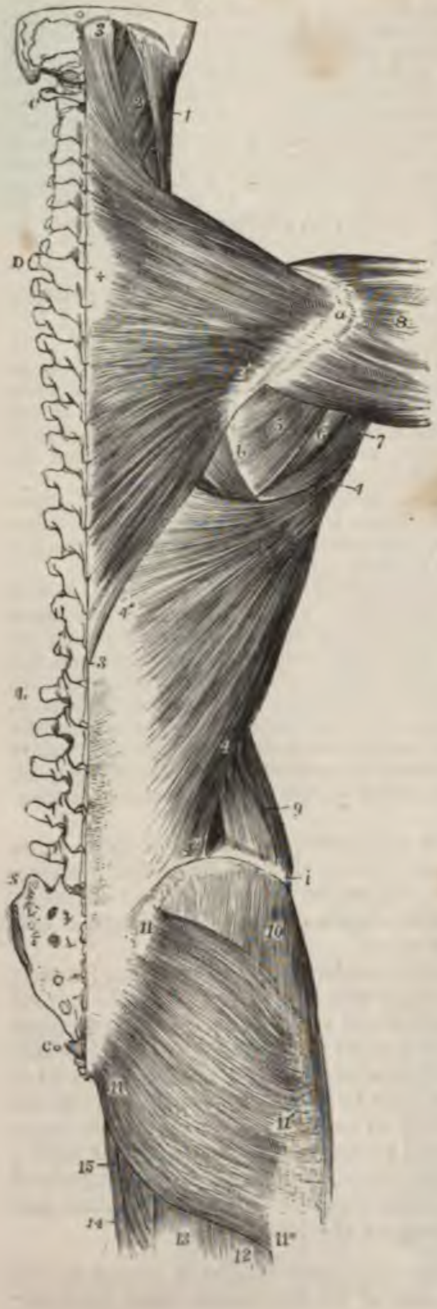


Fig. 156.—Superficial view of the muscles of the trunk, shoulder and hip. (After Bourgery.) (A. T.) ⅕

*o*, external occipital protuberance; C, transverse process of the atlas; D, first dorsal vertebra; L, first lumbar vertebra; S, first piece of the sacrum; Co, first piece of the coccyx; *a*, acromion; *b*, base of the scapula; *i*, crest of the ilium; 1, sterno-mastoid muscle; 2, splenius, levator anguli scapulæ, and other deep muscles; 3, 3, upper and lower ends of the line of origin of the trapezius muscle; 3′, triangular tendon attached to the inner end of the spine of the scapula; +, half of the oval tendon belonging to the two trapezius muscles in the lower cervical and upper dorsal region; 4, 4, latissimus dorsi; 4′, 4″, line along which the latissimus dorsi takes origin from the lumbar fascia; 5, infraspinatus; 6, teres minor; 7, teres major; 8, deltoid; 9, external oblique muscle of the abdomen; 10, gluteus medius, covered by the fascia lata; 11, 11, line of origin of the gluteus maximus from the posterior part of ilium to the coccyx; 11′, its insertion into the fascia lata over the great trochanter; 11″, a part of its insertion into the femur; 12, biceps; 13, semitendinosus; 14, adductor magnus; 15, gracilis.

cutaneous in the interval between the trapezius and latissimus dorsi; the extent of this portion varies with the position of the scapula, being increased when the arm is raised from the side. The rhomboidei cover the greater part of the serratus posticus superior, and the posterior scapular artery descends on their deep surface.

*Varieties.*—Both rhomboid muscles are liable to variations in the extent of their vertebral and scapular attachments. An additional muscle has been observed running close and parallel to the upper border of the minor, from the scapula to the occipital bone, and has been called *rhomboideus occipitalis* after a similar muscle occurring in some animals.

The **levator anguli scapulæ** arises by slightly tendinous slips from the posterior tubercles of the transverse processes of the four or five upper cervical vertebræ, between the attachments of the splenius and scaleni muscles, and forms an elongated fleshy mass which is inserted into the base of the scapula from the spine to the superior angle.

Fig. 157.

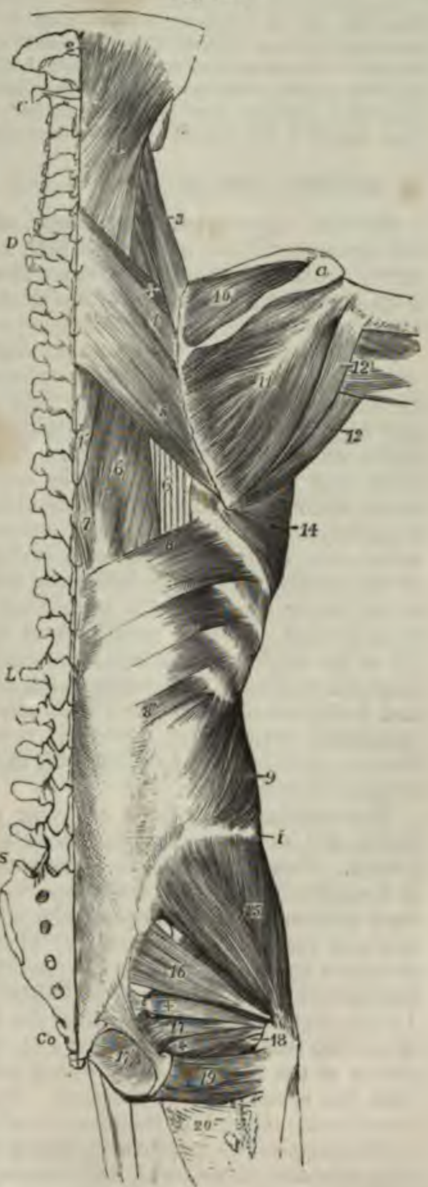


Fig. 157.—DEEPER VIEW OF THE MUSCLES OF THE TRUNK, SHOULDER AND HIP. (After Bourgery.) (A.T.) 1/5

The trapezius, latissimus dorsi, deltoid, gluteus maximus and external oblique muscles have been removed. The bones are lettered as in the preceding figure.

1, splenius capitis; 1', lower end of splenius colli; 2, complexus near its insertion; 3, levator anguli scapulæ; 4, rhomboideus minor; above it +, a part of the serratus posticus superior; 5, rhomboideus major; 6, part of the longissimus dorsi; 6', part of the tendons of insertion of the ilio-costalis; 7, part of the spinalis dorsi; 8, upper, and 8', lower part of the serratus posticus inferior; 9, internal oblique muscle; 10, supraspinatus; 11, infraspinatus; 12, placed upon the long head of the triceps, points to the teres minor; 13, teres major; 14, serratus magnus; 15, gluteus medius; 16, pyriformis; 17, portion of the obturator internus; + and +, superior and inferior gemelli; 17', the intrapelvic portion of the obturator internus; 18, tendon of the obturator externus passing to its insertion; 19, quadratus femoris; 20, upper part of the adductor magnus.

*Varieties.*—The number of vertebral attachments of the levator anguli scapulæ is subject to frequent variations. A slip has been observed to extend to it from the occipital or from the mastoid process of the temporal bone. It often appears as a divided muscle, the parts connected with the several vertebræ remaining separate, even to the place of insertion. It is occasionally connected by slips with the trapezius scalene, or serrated muscles. In quadrupeds it is united with the serratus magnus, so as to form a single muscle. Appearing as a detached bundle of the levator anguli scapulæ there is sometimes a muscular slip passing from the transverse processes of one or two upper cervical vertebræ to the outer end of the clavicle, and representing the *levator claviculæ* muscle of the lower animals.

**Nerves of the preceding muscles.**—The trapezius muscle receives its nerves from the spinal accessory which enters it on the deep surface, after being joined by branches from the third and fourth cervical nerves, and from these nerves directly. The latissimus dorsi is supplied by the long subscapular nerve of the brachial plexus. The nerves of the rhomboid muscles proceed in one or sometimes two branches from the fifth cervical, and the levator scapulæ is supplied from the third, the fourth, and sometimes also from the fifth cervical nerves.

### BETWEEN THE TRUNK AND THE UPPER LIMB ANTERIORLY.

FASCIÆ.—The **superficial fascia of the pectoral region** encloses the mammary gland, covering it both in front and behind, and sending strong septa in between its lobes. Processes likewise extend forwards from the fascial investment of the gland, between the masses of fat, to the skin and nipple, thus affording support to the gland.

The **deep fascia of the pectoral region** is for the most part thin and unimportant. Covering the pectoralis major it is attached superiorly to the clavicle and internally to the front of the sternum, while externally and below it becomes continuous with the fascia of the shoulder, of the axilla, and of the side of the chest. As a development of the deep fascia there may be specially noticed the *costo-coracoid membrane*, which is a strong fibrous structure, placed behind the pectoralis major, and attached superiorly to. the clavicle in two layers which ensheath the subclavius muscle, and of which the posterior is blended with the front of the sheath of the axillary vessels, derived from the deep fascia of the neck. The strong lower margin of the membrane, distinguished sometimes as the *costo-coracoid ligament*, extends from the coracoid process to the first rib at the origin of the subclavius muscle. From this membrane a thin lamina is prolonged downwards to the pectoralis minor, which it invests; and being continued beyond that muscle, it stretches across as a firm membrane between the pectoralis minor and the short head of the biceps, and ends below by joining the axillary fascia near the lower border of the pectoralis major.

The **axillary fascia** is a strong membrane stretched across the axilla, and so disposed as to maintain the skin in position over that hollow. Commencing at the lower border of the pectoralis major, where it is continuous with the fascia covering that muscle, it is joined by the layer descending from the pectoralis minor, and is by this means drawn upwards into the intermuscular hollow; thus strengthened it slopes outwards and backwards to the posterior fold of the axilla, where it is continued into the sheaths of the latissimus dorsi and teres major muscles. In the deepest part of the axilla the fascia is perforated by numerous lymphatic vessels. At the outer side, occupied by the large vessels and nerves of the limb, it is continuous with the sheath of the vessels and with the aponeurosis of the arm. The density of this fascia offers a considerable obstacle to the progress of axillary abscesses to the surface.

MUSCLES.—The **pectoralis major** muscle consists of two portions, *clavicular* and *sterno-costal*, which are separated at their origin by a slight interval opposite the sterno-clavicular articulation, but are united externally at the insertion of the muscle. The clavicular portion arises from an impression occupying the inner half of the anterior surface of the clavicle; the sterno-costal portion from the anterior surface of the sternum, from the cartilages of the upper six ribs and from the aponeurosis of the external oblique muscle of the abdomen. The fibres of the two portions converge, and form a thick mass which is inserted by a tendon of considerable breadth into the pectoral ridge of the humerus. The tendon of insertion is composed of two layers, which are only united for a limited extent along their lower margins. The anterior layer is formed by the upper sterno-costal fibres, and is also joined on its front surface by the descending clavicular portion of the muscle, the latter being prolonged downwards beyond the level of the sterno-costal fibres and becoming closely united with the tendon of the deltoid. The posterior layer of the tendon is formed by the lower sterno-costal fibres, which turn backwards successively behind the upper part; this layer of the tendon reaches higher on the humerus than the anterior, and from its upper border an expansion is given off, covering the long head of the biceps muscle, to the great tuberosity of the humerus and the capsule of the shoulder-joint. From the lower border of the tendon also a slip is prolonged to the fascia of the arm.

*Relations.*—The folded inferior border of the pectoralis major forms the anterior margin of the axilla; the superior runs parallel with that of the deltoid muscle, from which it is separated only by a slight interval which becomes wider towards the clavicle, and in which run the cephalic vein and the humeral branch of the acromio-thoracic artery. The anterior surface is subcutaneous in the greater part of its extent, being covered only by some of the fibres of the platysma myoides and by the mamma. The posterior surface rests chiefly on the pectoralis minor, and with that muscle forms the anterior wall of the axilla.

*Varieties.*—The more frequent varieties of this muscle consist in the greater or less extent of its attachments to the ribs or sternum, and the greater or less separation of its clavicular and sterno-costal parts. The clavicular part has occasionally been observed to be absent, or to be incorporated completely with the deltoid. The tendinous and fleshy fibres of origin of opposite sides sometimes meet and even decussate in front of the sternum. In some instances additional muscular slips take origin from the aponeurosis of the external oblique muscle, and in others considerable deficiency, or even absence, of the sterno-costal portion of the muscle has been observed. Sometimes also slips connect the great pectoral with the biceps muscle. The slips of connection with the latissimus dorsi have already been noticed.

*Chondro-epitrochlearis.*—This name has been given to a muscular slip which is occasionally seen, springing from one or two rib-cartilages, or from the aponeurosis of the external oblique, below the pectoralis major, or sometimes given off from the lower border or from the tendon of the muscle itself, and passing to a variable insertion on the inner side of the arm, to the fascia, to the intermuscular septum, or even to the internal condyle of the humerus.

The *sternalis* muscle is a fasciculus not unfrequently present on one or both sides, fleshy in the middle and tendinous at both ends, lying on the surface of the pectoralis major, parallel to the margin of the sternum. It springs below, variably, from the sheath of the rectus and the fifth and sixth costal cartilages, and terminates above in the sterno-mastoid, or sternum and upper rib-cartilages, or more rarely in the pectoralis major. When two are present, they frequently unite in front of the manubrium.

The **pectoralis minor** muscle arises from the upper margins and slightly from the external surfaces of three ribs near their cartilages—usually the third, fourth, and fifth—by tendinous slips which are blended with the anterior intercostal aponeuroses. Its fibres converge to a narrow tendon, which is inserted into the anterior half of the inner

Fig. 158.

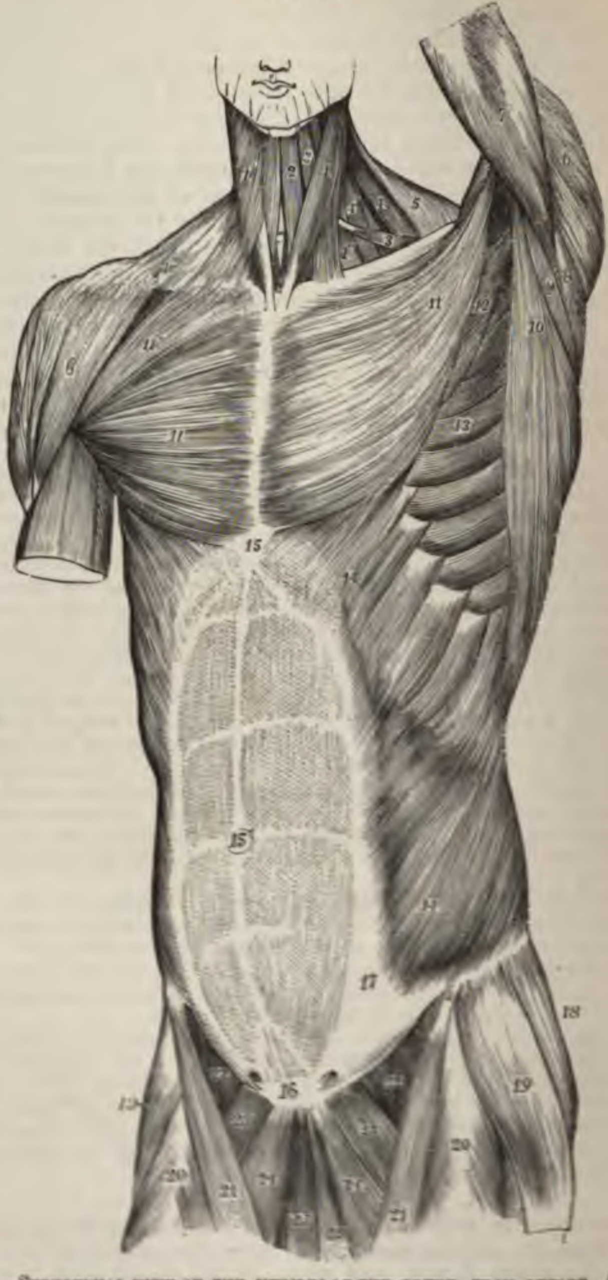


Fig. 158.—SUPERFICIAL VIEW OF THE MUSCLES OF THE TRUNK, FROM BEFORE. (A. T.) ¼

1, sterno-mastoid of the left side; 1', 1', platysma myoides of the right side; 2, sterno-hyoid; 3, anterior, 3', posterior belly of the omo-hyoid; 4, levator anguli scapulæ; 4', 4', scalene muscles; 5, anterior part of trapezius; 6, deltoid; 7, upper part of triceps in the left arm; 8, teres minor; 9, teres major; 10, latissimus dorsi; 11, pectoralis major; 11′, on the right side, its clavicular portion; 12, part of pectoralis minor; 13, serratus magnus; 14, external oblique muscle of the abdomen; 15, placed on the ensiform process at the upper end of the linea alba; 15′, umbilicus; 16, is placed over the symphysis pubis: at the lower end of the linea alba, above 16, the pyramidal muscles are seen through the abdominal aponeurosis; 14 to 17, linea semilunaris at the outer border of the rectus muscle, the transverse tendinous lines of which are seen through the abdominal aponeurosis; 18, part of the gluteus medius; 19, tensor vaginæ femoris; 20, rectus femoris; 21, sartorius; 22, femoral part of the ilio-psoas; 23, pectineus; 24, adductor longus; 25, gracilis. On each side of 16, the external abdominal ring is indicated.

Fig. 159.

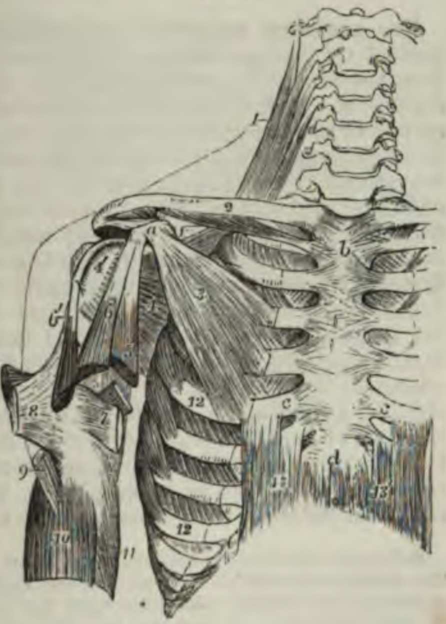


Fig. 159.—VIEW OF SOME OF THE DEEPER MUSCLES OF THE SHOULDER AND TRUNK, FROM BEFORE. (A. T.) $\frac{1}{5}$

On the right side the pectoralis major and external oblique muscles have been removed. *a*, coracoid process; *b*, manubrium; *c*, *c*, cartilages of the fifth ribs; *d*, ensiform process; 1, levator anguli scapulæ muscle; 2, on the middle of the clavicle, points to the subclavius muscle; 3, pectoralis minor; 4, subscapularis; 4′, its insertion into the small tuberosity of the humerus; 5, coraco-brachialis cut short; 6, coracoid, and 6′, glenoid head of the biceps brachii, both cut short; 7, on the tendon of the latissimus dorsi, points by a line to the tendon of the teres major, both cut short and passing to their insertion inside the bicipital groove; 8, folded tendon of the pectoralis major; 9, insertion of the deltoid; 10, brachialis anticus, embracing the insertion of the deltoid; 11, part of the inner head of the triceps, the middle head of which is seen passing behind the tendons of the latissimus and teres; 12, 12, on the fifth and eighth ribs, point to the origin of the serratus magnus; 13, 13′, recti abdominis.

border and upper surface of the coracoid process, in contact with the conjoined origin of the coraco-brachialis and biceps muscles.

*Relations.*—This muscle is covered by the pectoralis major, and forms a part of the anterior wall of the axilla. It crosses the axillary artery and brachial plexus of nerves. When the arm is much raised a portion of the muscle may be seen projecting beyond the lower margin of the pectoralis major.

*Varieties.*—The pectoralis minor is sometimes found split up or subdivided into as many pieces as it has costal attachments. The place and number of the costal slips are subject to slight variation. The tendon of insertion is not unfrequently detached in part or wholly from the coracoid process, and continued over that to the capsule of the shoulder and the great tuberosity of the humerus.

The **subclavius** muscle arises by a short thick tendon from the first costal arch at the junction of the rib and cartilage, close to the costo-clavicular ligament. From this tendon its fibres pass outwards and upwards, forming a prismatic belly, which is inserted into the groove on the under surface of the clavicle, extending as far as the recess between the conoid and trapezoid parts of the coraco-clavicular ligament.

*Relations.*—The subclavius is encased by the costo-coracoid membrane, and is placed immediately over the great vessels and nerves entering the limb.

*Varieties.*—The subclavius is sometimes found to be without any attachment to the clavicle, being inserted into the root of the coracoid process; or it may have a double insertion, the upper into the clavicle, the lower into the coracoid process. A part of this muscle, or occasionally an independent fasciculus, may be inserted into the upper border of the scapula, constituting the *sterno-scapular* muscle of Wood.

The **serratus magnus** muscle, placed upon the upper and lateral part of the thorax, between the ribs and the scapula, arises anteriorly from the first eight or sometimes nine ribs by as many fleshy slips or digitations; each digitation being attached to the fore part of the outer surface of the corresponding rib, with the exception of the first, which is attached to two ribs. Posteriorly, the muscle, considerably narrowed, is inserted into the line in front of the base of the scapula, and at the upper and lower angles of the bone into the flat surfaces which are excluded from the fossa of the subscapular muscle. The fibres are arranged in three sets, thus:—*a*, those of the first digitation, springing from the first and second ribs and an intervening aponeurotic arch, form a thick bundle which terminates on the flat area in front of the upper angle of the scapula; *b*, those of the second and third digitations, from the second and third ribs, but especially the first of these, spread out into a triangular layer, the thinnest part of the muscle, and are attached along the line in front of the base of the scapula, extending from the place of insertion of the preceding part nearly to the lower angle of the bone; *c*, the remaining five or six digitations converge in the form of a fan, and terminate posteriorly in a thick mass, which is attached to the flat surface in front of the lower angle of the scapula.

*Relations.*—By its deep surface, the serratus magnus rests on the upper ribs, the intercostal muscles, and part of the serratus posticus superior. Its outer surface is in contact posteriorly with the subscapular and latissimus dorsi muscles, and forms anteriorly the internal wall of the axilla, being subcutaneous in the lower part of its extent.

*Varieties.*—Not unfrequently the muscle receives a slip also from the tenth rib: on the other hand, the highest digitation often has no attachment to the first rib: or one or more of the lower digitations may be absent, so that the muscle does not pass lower than the seventh rib. The muscle has been observed divided into three parts: sometimes the middle part is absent: and in various instances the serratus has been observed united partially with the levator scapulæ, the external intercostals, or the external oblique. With the levator scapulæ it forms one muscle in many mammals.

**Nerves.**—The nerves which supply the anterior muscles passing from the trunk to the upper limb are all derived from parts of the brachial plexus. The nerve of the subclavius is a small twig from the trunk formed by the fifth and sixth cervical nerves. The large nerve of the serratus magnus, called posterior thoracic, proceeds from the fifth and sixth, sometimes also the seventh nerves, and pierces the middle scalene muscle. The nerves of the pectoral muscles, named anterior thoracic, are two in number, internal and external, proceeding respectively from the inner and outer cords of the plexus, the outer supplying the great pectoral muscle, the inner both it and the lesser pectoral.

**Actions of the muscles passing between the Trunk and Upper Limb.** —Considered with reference to the movements of the limb upon the trunk, he upper part of the trapezius, the levator scapulæ and the rhomboid muscles are elevators of the shoulder; the lower part of the trapezius, the pectoralis minor, and the subclavius are depressors; the serratus magnus as a whole carries forwards the scapula, and the rhomboidei draw it back; the latissimus dorsi and pectoralis major depress the humerus and carry it towards the middle line, behind or in front, according as the one or other muscle is in action.

Fig. 160.

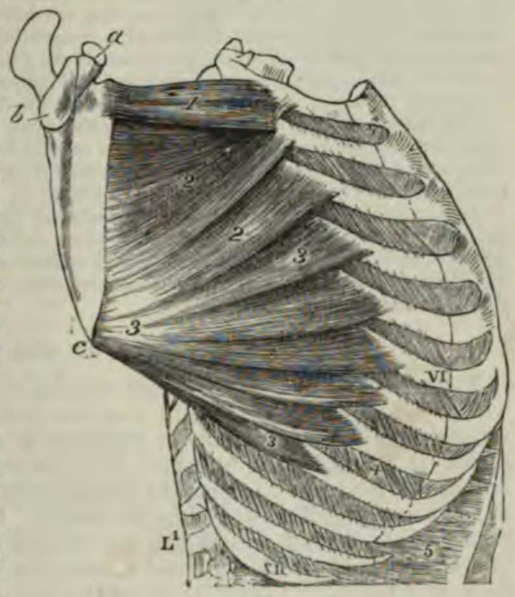


Fig. 160.—LATERAL VIEW OF THE TRUNK, SHOWING THE SERRATUS MAGNUS MUSCLE. (A. T.) ⅕

*a*, coracoid process of the apula; *b*, glenoid cavity; lower angle; I, VI, XII, he first, sixth, and twelfth bs; 1, upper portion of he serratus magnus attached the first and second ribs; 2, second or middle poron attached to the second nd third ribs; 3, lower or nshaped portion attached to he ribs from the fourth to he ninth; 4, external tercostal muscle; 5, costal rigins of the transversalis bdominis.

More particularly, the uperior fibres of the *traezius* elevate the clavicle; he middle fibres acting on he acromion have also ome elevating action, but end rather to carry back he scapula towards the pine; the inferior part of he muscle acting upon the spine of the scapula would of itself depress that bone hile it carries it inwards towards the dorsal spines, but acting in concert with he upper two-thirds of the muscle, a rotation is produced in the scapula round a entral point, in such a manner that while the whole bone, and more especially he acromion, is raised and carried towards the dorsal spines, the upper angle of he scapula is somewhat depressed and carried inwards, while the lower angle is arried outwards and elevated.

The *levator anguli scapulæ* and *rhomboidei* elevate the superior angle and base f the scapula, thus counteracting the rotating action of the trapezius. In this nanner, when the trapezius, levator, and rhomboid muscles act together, the capula is raised without rotation, and its base is carried at the same time inwards, towards the dorsal spines.

The *subclavius* depresses the clavicle, and may also act as a support to the terno-clavicular articulation.

The *pectoralis minor* draws the coracoid process downwards and forwards, and ends to throw the lower angle of the scapula backwards.

The *serratus magnus* muscle, by withdrawing the base of the scapula from the pinal column, enables the arm when raised from the shoulder to be still farther utstretched, as in the movement termed extension in fencing. It comes powerfully into action in all movements of pushing; its lower portion likewise combines with the trapezius in rotating the scapula. In forced inspiration, the scapula being fixed by the muscles which attach it to the trunk posteriorly and superiorly, the lowest slips of the serratus magnus may assist in dilating the chest by raising and everting the ribs.

The *latissimus dorsi* carries the elevated arm downwards and backwards, rotating it at the same time inwards, so as to make the palm look backwards, thus accomplishing such a movement as is made by the arm in swimming. By passing over the angle of the scapula it binds that part to the trunk, preventing its projection backwards; and by being folded round the outer border of the scapula, it limits the projection outwards of the same angle when the arm is raised.

The *pectoralis major* muscle, while it combines with the latissimus dorsi in depressing the humerus from the raised position, opposes that muscle by drawing the limb forwards. It is placed upon the stretch when the arms are thrown backwards, and is most shortened when they are folded across the chest. In the remarkable case of Groux, affected with congenital cleft sternum, when the shoulders were fixed backwards, the action of the great pectoral muscles tended to separate the two segments of the sternum, and increased the space in which the motions of the heart could be observed through the integuments.

Considered as acting on the trunk from the upper limb in a fixed condition, these muscles all tend to draw the trunk of the body towards the limb, as in climbing, or other like efforts. The latissimus dorsi muscles, if acting on both sides, carry the body upwards and forwards, as in the use of crutches. The pectorales and latissimus dorsi are also muscles of forced inspiration, tending to raise and evert the ribs, more especially when the shoulders are fixed and the arms are elevated. The upper parts of both trapezii acting on the occipital bone aid in extending the head on the vertebral column; and if one muscle only acts, it aids in rotating the head.

## MUSCLES AND FASCIÆ OF THE SHOULDER.

FASCIÆ.—The **deep fascia** binds together the muscles of the shoulder with considerable firmness, and over the back part of the deltoid and infraspinatus muscles assumes a tendinous appearance. A strong and somewhat isolated portion, bound down to the vertebral and axillary margins of the scapula, covers the infraspinatus and teres minor muscles as far as they are left uncovered by the deltoid. On reaching the posterior border of the deltoid muscle, this aponeurosis divides into two layers, of which the deeper is continued beneath the deltoid to the shoulder-joint, and the more superficial forms the thin aponeurotic covering of that muscle, becoming more and more slender as it passes forwards, and is attached to the lower border of the spine.

MUSCLES.—The **deltoid** muscle is of a triangular form and coarsely fasciculated, and extends from the most prominent part of the shoulder downwards for half the length of the upper arm. It takes origin in an extended line which may be divided into three portions, viz., an anterior from the front of the external third of the clavicle, a middle from the point and outer edge of the acromion, and a posterior from the lower border of the spine of the scapula as far back as the triangular surface at its inner end. The fasciculi from these several parts converge as they descend, and are inserted by a strong thick tendon into the deltoid impression, a triangular rough surface above the middle of the humerus on its outer side.

The three parts composing the deltoid muscle differ somewhat in the disposition of the muscular fasciculi and the tendons. The anterior and posterior portions are composed of parallel fasciculi which, arising from the clavicle by short tendinous fibres, and by longer ones from the spine of the scapula, are inserted into the outer surface of the marginal parts of the inferior tendon. In the acromial portion, while some of the muscular fibres spring directly from the bone, yet most of them arise in a penniform manner from the sides of three or, more

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leltoid, its clavicular part
cromial part ; 3, biceps
3′, its tendon of insertion ;
neurotic slip ; 4, brachialis
4′, its inner and lower por-
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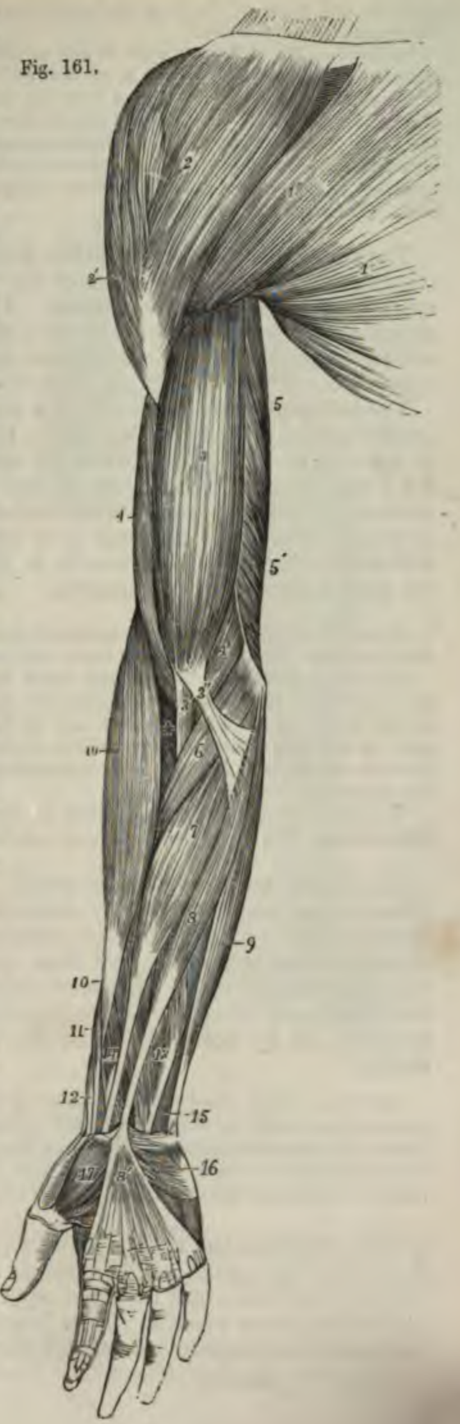
Fig. 161.



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ions of the supraspina-
pinatus and teres minor

muscles, and parts of the long and outer heads of the triceps, as also the circumflex vessels and nerve.

*Varieties.*—The deltoid muscle is not subject to great varieties. One of the commonest is a greater degree of subdivision of its parts than usual. Another is the continuation into it of fibres from the trapezius, as in animals wanting the clavicle. Occasionally the anterior part is closely united in its whole length with the great pectoral muscle. Its insertion varies sometimes in extent. A remarkable prolongation of its tendon on the radial border of the forearm, as far as the insertion of the supinator longus, seems to repeat the tensor plicæ alaris of the bird. (Macalister.)

The **supraspinatus** muscle arises from the supraspinous fossa of the scapula to within a short distance of the neck of the bone, and from an aponeurosis by which it is covered. Its fibres converge beneath the acromion to a tendon, which adheres to the capsule of the shoulder-joint and to the tendon of the infraspinatus muscle, and is inserted into the upper of the three facets on the great tuberosity of the humerus.

The **infraspinatus** muscle is of a triangular form, and occupies the greater part of the infraspinous fossa. It arises from the fascia covering it, from the under surface of the spine, and from the inner two-thirds of the dorsal surface of the scapula in the fossa, except those parts at the lower angle and along the external border, to which the teres muscles are attached. The fibres converge to a tendon, which, concealed at first within the substance of the muscle, is inserted into the middle facet of the great tuberosity of the humerus.

*Relations.*—The supraspinatus muscle is covered by the trapezius and the acromion process. The suprascapular nerve and vessels pass beneath it.

The infraspinatus muscle is bound down by the aponeurosis which superiorly and externally divides so as to enclose the deltoid muscle. It is covered by the deltoid at its upper and outer part, and by the trapezius at its upper and inner part, by the latissimus dorsi at its lower angle, and in the intermediate portion it remains superficial. A small bursa is sometimes present between the tendon and the capsule of the shoulder-joint.

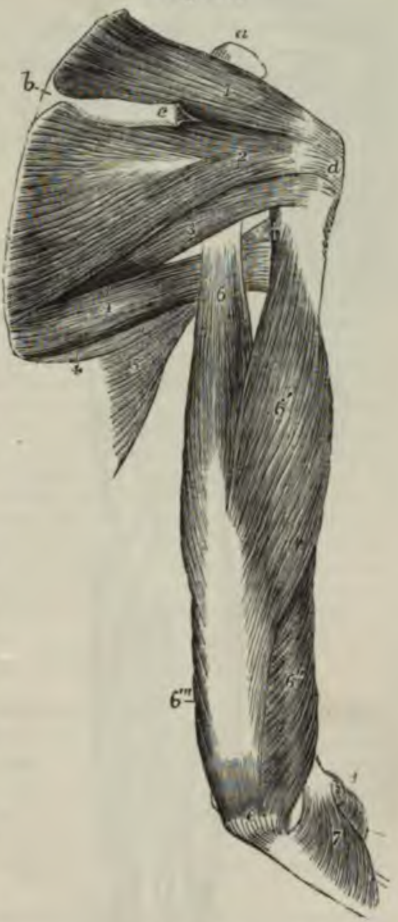
*Varieties.*—The infraspinatus muscle is sometimes inseparably united with the teres minor. The supraspinatus is very constant in its form and attachments.

The **teres minor** muscle is placed along the outer border of the infraspinatus, and is intimately connected with that muscle. It arises from a narrow obliquely grooved surface on the dorsum of the scapula close to the axillary border, and from aponeurotic septa between it and the infraspinatus and teres major muscles, and is inserted by tendon into the greater tuberosity of the humerus, immediately below the infraspinatus, and by fleshy fibres into the bone for a short distance lower down.

*Relations.*—This muscle is partly covered behind by the deltoid, and in front is in contact with the long head of the triceps, and the capsule of the shoulder-joint. The dorsal scapular artery passes between it and the bone. At its lower border is the teres major separated in part by the long head of the triceps. A bursa is sometimes found between the tendon and the bone.

The **teres major** muscle arises from the flat oval surface on the dorsum of the scapula near its inferior angle, slightly from the axillary border of the bone, and from the septa between it and the teres minor and infraspinatus muscles. It is inserted by a flat tendon, about two inches wide, into the inner border of the bicipital groove of the humerus, ɪd in contact with the tendon of the latissimus dorsi, to which rent for a short space. Close to the insertion, however, the f these muscles are separated by a small bursa. The fibres run ally in the muscle.

Fig. 162.



-Muscles of the right and arm, seen from (A.T.) ¼

nion process and a part of of the scapula, with the scle, have been removed. process; *b*, triangular sur- root of the spine; *c*, is close portion of the spine; *d*, sity; *e*, olecranon; *f*, is external condyle and head us; 1, supraspinatus; 2, s; 3, teres minor; below s the triangular space; 4, ; 5, part of latissimus dorsi; n the inferior angle of the on the edge of the humerus, e tendon of the latissimus he quadrangular space; 6, ad of the triceps, passing een the teres major and outer head; 6'', part of the g below the spiral groove, with the inner head; 6''', inner head; 7, anconeus.

*s.*—Posteriorly this covered at its lower part issimus dorsi, and at its it is crossed by the long the triceps. The lower surrounded obliquely by nus dorsi; and the an- ace is concealed in the t of its extent by the that muscle. The upper the muscle forms the a triangular space, of other sides are the upper humerus, and the axil- r of the scapula, covered the subscapular and be- he teres minor muscles; le is divided by the long e triceps into an external, quadrilateral, and an internal, triangular ent. Through the quadrilateral space pass backwards the posterior vessels and the circumflex nerve; and in the triangular subdivision branch of the subscapular artery passes round the margin of the sca- the infraspinous fossa.

*s.*—The teres major muscle is sometimes found connected with the of the latissimus dorsi arising from the same part of the scapula. A this muscle has also been observed descending upon the fascia of the externally.

**ubscapularis** muscle arises partly by muscular and partly by s fibres from the venter of the scapula, with the exception of

Fig. 163.

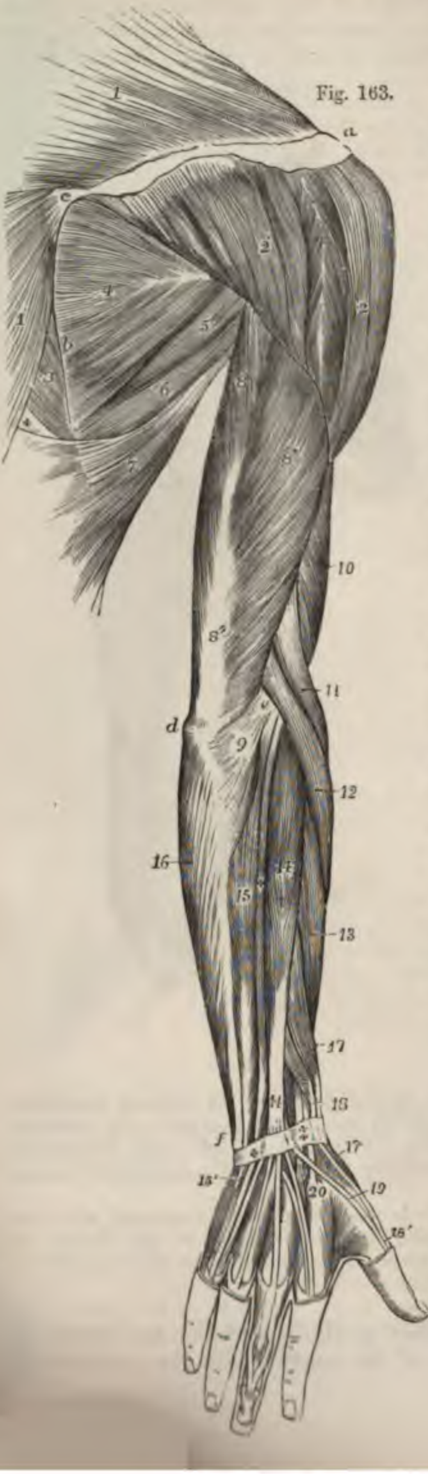


Fig. 163.—Superficial muscles of the shoulder and upper limb, seen from behind. (A. T.) ⅓

*a*, acromion; *b*, base of the scapula; *c*, tendon of the trapezius muscle over the triangular surface of the spine of the scapula; *d*, olecranon; *e*, external condyle; 1, trapezius; 2, acromial part of deltoid; 2′, the part of the same muscle rising from the spine of the scapula; 3, rhomboideus major; 4, infraspinatus; 5, teres minor; 6, teres major; 7, latissimus dorsi; +, space between the trapezius, rhomboid and latissimus muscles; 8, long head of triceps; 8′, its outer head; 8″, its tendon; 9, anconeus; 10, part of the brachialis anticus; 11, supinator longus; 12, extensor carpi radialis longior. The explanation of the remaining references will be found in the description of fig. 168.

the neck and the spaces occupied by the serratus magnus, but including the groove along the axillary border of the bone. The greater number of its fibres unite into a broad tendon which is inserted into the impression on the small tuberosity of the humerus; some of the lower fibres, however, are directly inserted into the bone for a short distance farther down. Three or four tendinous septa, attached to the ridges of the subscapular fossa, pass outwards in the origin of the muscle; and others are prolonged inwards from the tendon of insertion.

*Relations.*—The tendon of the subscapularis is incorporated with the capsule of the shoulder-joint, and between its upper border and posterior surface, and the coracoid process and neck of the scapula is a bursa usually communicating with that joint. There is sometimes another bursa intervening between the anterior surface of the muscle and the upper ends of the biceps and coraco-brachialis muscles. Anteriorly the muscle is in contact at its origin with the serratus magnus, and is covered at its insertion by the coraco-brachialis and biceps, while, in the interval between, it forms part of the posterior wall of the axilla.

*Varieties.*—The varieties hitherto observed in this muscle are not considerable. A small additional muscle, of somewhat variable form, has been described by different authors, as passing from the upper part of the axillary border of the scapula to be inserted, at the lower margin of the subscapularis, into the capsular ligament, or into the humerus near the inner margin of the bicipital groove, the *subscapulo-capsularis* of Macalister.

**Nerves of the Shoulder Muscles.**—The supraspinatus and infraspinatus muscles receive their nerves from the suprascapular branch which proceeds from the upper trunk of the brachial plexus, and therefore from the fifth and sixth cervical nerves. The other muscles of this group are all supplied with nerves from the posterior division of the plexus, as follows: the deltoid and teres minor from the circumflex nerve, the subscapularis and the teres major from the upper and lower subscapular nerves.

**Actions of the Shoulder Muscles.**—The *deltoid* muscle raises the arm from the side as far as the structure of the shoulder-joint permits, viz., till it is at right angles with the trunk. Farther elevation of the upper limb is effected chiefly by the serratus magnus and trapezius; and it may be remarked that the insertion of the latter muscle corresponds almost exactly in extent to the origin of the deltoid, so that the two muscles may be considered continuous in structure as well as in action. The anterior fibres of the deltoid combine with the pectoralis major to draw the humerus forwards; the posterior assist in drawing it backwards. The supraspinatus, infraspinatus and subscapularis muscles being placed more closely round the joint, when acting in concert with the deltoid, probably give steadiness and precision, while the deltoid gives the main elevating force to the movement. The *supraspinatus* simply abducts: the *infraspinatus* and *subscapularis* carry the arm backwards or forwards when it is raised, and rotate it outwards or inwards when hanging by the side. The *teres major* rotates the raised humerus inwards, the *teres minor* outwards: acting together, they assist in depressing the arm. The deltoid muscle superficially, and the supra- and infraspinatus muscles, the teres minor and subscapularis, more deeply, afford important protection to the shoulder-joint, and by their tension prevent displacement of the head of the humerus.

## MUSCLES AND FASCIÆ OF THE UPPER ARM.

FASCIÆ.—The **aponeurosis of the arm** is composed chiefly of transverse fibres, held together by others having an oblique or longitudinal direction; it is thin over the biceps muscle, stronger where it covers the triceps, and particularly dense as it approaches the outer and inner condyles of the humerus. It is pierced on the inner side of the limb by the basilic vein, close below the middle of the arm. It is attached to the condyles and supracondylar ridges of the humerus by the two processes next to be described.

The **external** and **internal intermuscular septa** are two fibrous partitions which bind the aponeurosis of the arm to the humerus, and with which the neighbouring muscles of the arm are intimately connected. The external intermuscular septum extends upwards from the outer condyle along the outer supracondylar ridge to the insertion of the deltoid, from which it receives tendinous fibres. It is pierced from behind forwards by the musculo-spiral nerve and superior profunda artery. The internal septum, much stronger, extends along the ridge from the inner condyle to the insertion of the coraco-brachialis muscle. It is pierced near the elbow, from before backwards, by the anastomotic branch of the brachial artery.

At the level of the elbow the aponeurosis is closely united to the periosteum covering the subcutaneous parts of the bones, viz., the condyles of the humerus and the olecranon process of the ulna; and it is strengthened in front and behind by tendinous fibres sent from the biceps and triceps muscles.

MUSCLES.—The **coraco-brachialis** muscle, elongated in form, arises from the tip of the coracoid process of the scapula, between the pectoralis minor and the short head of the biceps, with which latter it is for some distance conjoined in a common tendon. The lower end of the muscle is inserted into the inner border of the humerus near its middle, on a linear impression of from one to two inches in length, between the origins of the triceps and the brachialis anticus. Higher up some of its fibres are frequently inserted into a fibrous band which is prolonged upwards, forming an arch over the latissimus dorsi and teres major tendons, to be attached to the humerus close below the small tuberosity.

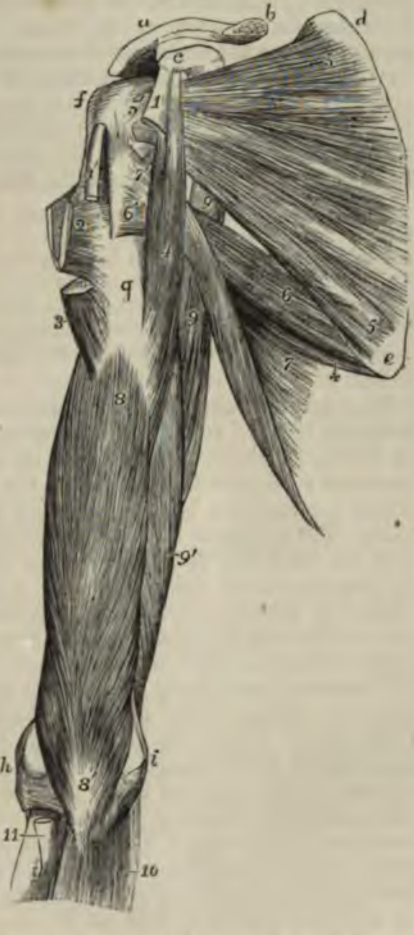
*Relations.*—This muscle is usually pierced by the musculo-cutaneous nerve; its outer border is in contact with the biceps muscle, and its inner with the brachial artery, by which it is crossed obliquely near its insertion. It lies in front of the tendons of the subscapularis, latissimus dorsi, and teres major, and is covered in great part by the deltoid and pectoralis major muscles.

*Varieties.*—This muscle has been shown by various authors to be subject to considerable varieties, which seem to indicate, according to Wood, that it consists typically of three parts; viz., 1, a superior short one rising from the coracoid process, or near it, and running over the subscapularis muscle, to be inserted close below the small tuberosity of the humerus; 2, a middle part corresponding most nearly to that usually described in human anatomy, of intermediate size, and placed between the first and third; 3, an inferior part, which is the longest and most superficially placed, and descends to the inner condyle, or near it, and in many instances is inserted into a supracondylar process. The middle division of the muscle is most constant in man; but is generally accompanied by a part of the third; the musculo-cutaneous nerve passing between them. The first and third constitute the most marked varieties in man, and all three are found in various forms and degrees of development in different animals. The internal brachial ligament of Struthers is a fibrous band connected with the inferior part of this muscle. (Wood, Journ. Anat. i. 45.)

The **biceps flexor cubiti** muscle has two heads of origin: one of these, the *internal* or *short head*, arises conjointly with the coraco-brachialis from the coracoid process of the scapula by a tendon which is soon continued into muscle; the other, the *long head*, arises from the scapula at the upper end of the glenoid cavity, within the capsule of the shoulder-joint, by a rounded tendon which is continuous on each side with the glenoid ligament; and this tendon, passing over the head of the humerus, leaves the joint by the bicipital groove, gradually enlarging into the fleshy head as it descends. The two muscular heads meet, and becoming closely applied together form an elongated and thick belly, occupying the middle and lower part of the arm: a little above the bend of the elbow, the muscle suddenly becomes narrower, and is continued into the thick tendon of insertion. This tendon, slightly twisted upon itself as it descends, is inserted into the rough posterior portion of the tuberosity of the radius, gliding on the anterior smooth surface of that process by the intervention of a synovial bursa. From the inner side of the lower part of the muscle and tendon a strong flat aponeurotic band, called the *semilunar fascia*, passes downwards and inwards, and becomes blended with the deep fascia of the forearm over the muscles arising from the internal condyle.

ɪ.—Concealed above by the deltoid and pectoralis major muscles, the
of the biceps forms in the rest of its extent the prominence of the front
. It lies in its upper part on the humerus, and in its lower on the bra-
cus, and by its inner margin is in contact in its upper half with the coraco-
in its lower with the brachial artery. Its inferior tendon passes back-

Fig. 164.



DEEP VIEW OF THE MUS-
-HE RIGHT SHOULDER AND
M BEFORE. (A. T.) ¼

er half of the clavicle; *c*,
ocess; *d*, upper, and *e*,
gular spaces at the upper
ngles of the scapula on its
face to which the serratus
attached; *f*, great tube-
surface of the humerus
icipital groove; *h*, outer
condyle; 1, cut coracoid
', cut glenoid tendon of
nuscle; 2, double tendon
of the pectoralis major,
a prolongation is seen
to the capsule of the
, insertion of the deltoid;
chialis; 5, subscapularis;
tion into the small tube-
eres major; 6', its inser-
and below the latissimus
rt of the latissimus dorsi;
n the inferior angle of the
, insertion of the tendon,
ng round the teres major,
and higher than that
, 8', brachialis anticus;
ead of the triceps, at the
seen in the interval be-
eres major and subscapu-
es; 9', inner head; 10,
fundus digitorum; 11,
nsertion of the biceps.

veen the supinator longus
or teres muscles, and the
xpansion or semilunar
stretched across the
essels and median nerve.
ɪ.—The biceps is one of
variable muscles in the
e commonest variety is
rence of a third head
ses from the humerus
less close connection with the brachialis anticus and the insertion of
-brachialis, and is inserted into the coracoid portion of the muscle
semilunar fascia: this head lies generally on the outer side of the
rtery, but has sometimes been found covering the vessels. Less fre-
additional head springs from the outer side of the humerus, from the
roove, or from the great tuberosity. In rarer cases two supplementary
present, arising from different parts of the humerus. Occasionally a
is given off from the inner border of the muscle to the internal inter-
septum, or to the internal condyle, passing over the brachial artery;
uli have been seen passing to the pronator teres and to the brachialis
In a few cases absence of the long head has been observed; in others

this head has been found to be attached in the bicipital groove, not extending to the scapula.

The **brachialis anticus** muscle arises from the lower half of the front of the humerus and from the intermuscular septa of the arm. At the upper part of its origin it embraces the insertion of the deltoid by two angular fleshy processes; it extends downwards to the capsule of the elbow-joint, and inwards to the internal supracondylar ridge and the intermuscular septum in its whole extent; on its outer side it is separated from the intermuscular septum in the greater part of its length by the supinator longus and extensor carpi radialis longior, and only arises from it for a short distance at its upper end. It is closely adherent to the anterior ligament of the elbow-joint, and terminates below in a thick mass which is inserted into the rough triangular surface on the front of the coronoid process of the ulna.

*Relations.*—This muscle lies immediately behind and projects on each side of the biceps. It supports the brachial vessels and median nerve. On the outer side the musculo-spiral nerve lies upon it, under cover of the supinator longus.

*Varieties.*—This muscle is subject to considerable variation. The most frequent of these consist in its subdivision into two or sometimes more parts; its union with neighbouring muscles, such as supinator longus, pronator teres or biceps; insertion of a slip from it into the semilunar fascia; and occasionally into the radius.

The **triceps extensor cubiti** (figs. 162, 163) occupies the whole posterior brachial region. The muscle consists of three separate portions or heads, which are united below in a common tendon occupying the posterior surface of the mass from the middle of the arm to the elbow, where it terminates by being inserted into the olecranon process of the ulna. The *middle* or *long head* arises from the rough triangular impression on the lower part of the neck, and the adjacent portion of the axillary border of the scapula, by a tendon which spreads over the surface of the muscular structure proceeding from it. This head forms the middle and superficial part of the muscle, and its fibres end on the inner margin of the common tendon. The *external head* takes origin by tendinous and fleshy fibres from the upper and outer part of the posterior surface of the humerus, extending from the insertion of the teres minor downwards as low as the spiral groove, and from an aponeurotic arch formed by the external intermuscular septum as it crosses the upper part of the groove: its fibres, which are comparatively short, descend obliquely to be inserted into the upper end and outer border of the tendon. The *internal* or *deep head*, the shortest of the three, arises from the whole extent of the posterior surface of the humerus below the spiral groove, on the inner aspect of the arm reaching by a pointed process as high as the insertion of the teres major; it also rises from the internal intermuscular septum in all its length, and from the inferior portion of the external septum. Some of its lower fibres are inserted immediately into the olecranon, but the greater part of them join the deep surface of the common tendon. No muscular fibres arise from the spiral groove itself. The insertion of the common tendon takes place into the posterior part of the upper surface of the olecranon, a small bursa intervening between it and the fore part of the surface; from its outer side also a considerable band is prolonged downwards over the anconeus, blending with the fascia, in which the fibres can be followed to the posterior border of the ulna.

*Relations.*—The long head of the triceps lies between the two teres muscles above, and is closely connected to the capsule of the shoulder-joint. The musculo-spiral nerve and the superior profunda artery are deeply imbedded in the muscle, and in the spiral groove pass between the inner and outer heads.

*Varieties.*—The most frequent varieties of the triceps muscle are the following, viz. :—1, an additional or fourth head arising from the inner part of the humerus, above or near the inner head; and 2, a slip of connection between the triceps and the latissimus dorsi, corresponding with the *dorso-epitrochlearis* or *accessorius tricipitis* which is common among quadrumana, and exists in many other mammals. The *epitrochleo-anconeus* of Wenzel Gruber is a small muscle frequently present, rising from the back of the inner condyle, and inserted into the olecranon : it lies over the ulnar nerve.

*Subanconeus.*—On removing the triceps from the lower part of the humerus, a few muscular fibres are sometimes found passing from that part of the bone to the capsule of the elbow-joint. These fibres, which are analogous to the subcrureus in the lower limb, have been described as distinct from the triceps under the name subanconeus.

The **anconeus** muscle, although placed chiefly below the elbow and in the forearm, is intimately connected with the triceps, and may be most appropriately associated in description with that muscle. It arises by a narrow tendon from a slight impression on the posterior surface of the external condyle of the humerus. From this the fibres diverge, the upper being transverse, the rest passing downwards with increasing degrees of obliquity, and are inserted into the olecranon on its radial aspect, and into the adjacent impression on the upper third of the shaft of the ulna. Its superior fibres are parallel to the lowest fibres of the internal head of the triceps, and are generally continuous with them.

*Relations.*—This muscle is subcutaneous in its whole extent. Its deep surface is in contact with the supinator brevis and the external lateral ligament of the elbow-joint.

*Varieties.*—The anconeus varies chiefly in being more or less united to the triceps or the extensor carpi ulnaris.

**Nerves of the Brachial Muscles.**—The three anterior flexor muscles are all supplied from the musculo-cutaneous nerve : the brachialis anticus, however, receives also a small twig from the musculo-spiral nerve. The triceps and anconeus receive their nerves entirely from the musculo-spiral.

**Actions.**—The *biceps* muscle raises the arm at the shoulder and flexes the elbow-joint ; the short head of the biceps draws the arm inwards as well as upwards, as does also the *coraco-brachialis.* If the biceps be called into action when the hand is in pronation, its first effect, from its insertion into the back part of the tuberosity of the radius, is to produce supination of the forearm. The biceps also makes tense the fascia of the forearm. The *brachialis anticus* is a simple flexor of the elbow. The external and internal heads of the *triceps* and the *anconeus* are simple extensors of the elbow-joint; the long head, while it assists in extending the elbow, also tends to depress the arm on the scapula.

## MUSCLES AND FASCIÆ OF THE FOREARM.

FASCIÆ.—The **superficial fascia of the forearm** is most distinct opposite the bend of the elbow, where the superficial veins contained between its laminæ are numerous and large. In the palm of the hand, on the contrary, the subcutaneous tissue forms a firm connecting medium between the skin and a strong aponeurosis named the palmar fascia; it consists of a network of fibres passing between those two structures, dividing the subcutaneous fat into small granular masses, and preventing the skin from shifting to any considerable extent.

The **aponeurosis of the forearm**, like that of the arm, is composed principally of transverse fibres, strengthened, however, by longitudinal and oblique fibres descending from the condyles of the humerus, from the olecranon, from the semilunar fascia of the biceps and from the tendon of the triceps. It is attached along the subcutaneous margin of the ulna, and may be conveniently divided into an anterior and a posterior part.

The *anterior part* of the aponeurosis of the forearm is much weaker than the membrane on the posterior aspect of the limb. It is continued below into the anterior annular ligament of the wrist. Over the hollow immediately below the bend of the elbow, it presents a small oval aperture for the transmission of a short communicating branch between the superficial and the deep veins of the forearm. It increases in density towards the hand; and a little above the wrist affords a sheath to the tendon of the long palmar muscle, which passes over the annular ligament to be inserted into the narrow end of the palmar fascia. Several white lines seen on the surface of the fascia near the elbow mark the position of the septa between the origins of the muscles descending from the inner condyle, which are continuous with it, and which, together with the adjacent portions of the fascia, give origin to the muscular fibres. Between the superficial and the deep flexor muscles, another layer of fascia is stretched from side to side; it is stronger below than above, where it generally consists of little more than thin connective tissue.

The *anterior annular ligament* of the carpus, previously described at p. 161, is continuous at its upper margin with the fascia of the forearm and receives some fibres from the tendon of the flexor carpi ulnaris: the anterior surface and lower margin are connected with the palmar fascia, and give origin in part to most of the short muscles of the thumb and little finger. This structure may be considered in some measure as a deep thickened portion of the fascia of the wrist.

The *posterior portion* of the aponeurosis of the forearm, much thicker than the anterior, is intimately connected with the strong septa between the several superficial muscles, and sends off transversely a thin membrane to separate the superficial from the deeper group of muscles. Approaching the back of the wrist, the transverse fibres increase in number and strength, and these, being stretched somewhat obliquely from the outer margin of the radius on one side to the pyramidal and pisiform bones and the palmar fascia on the other, constitute the *posterior annular ligament* of the carpus. This structure is attached not only to the points now indicated, but is likewise connected to the several longitudinal ridges on the posterior surface of the radius, and thus converts the intermediate grooves into fibro-osseous canals which lodge the tendons of the extensor muscles. There are six separate spaces so enclosed, and each is lined by a distinct synovial sac. The outermost space corresponds with the groove on the outer side of the radius, and gives passage to the extensores ossis metacarpi and primi internodii pollicis; the next three, placed on the back of the radius, give passage respectively to the two radial carpal extensors, the extensor secundi internodii pollicis, and the common extensor of the fingers, with the extensor indicis accompanying it; between the radius and ulna is the compartment for the extensor minimi digiti; and corresponding to the groove on the back of the ulna is that for the extensor carpi ulnaris.

## PRONATOR AND FLEXOR MUSCLES.

eight muscles on the front and inner part of the forearm are l in two sets, five being superficial, the others more deeply

SUPERFICIAL LAYER of muscles comprehends the pronator radii exor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor s digitorum. These five muscles are intimately united at their from the inner condyle, being attached to this by a common which gives fibres to each, and also sends septa between them. **pronator radii teres** muscle, the most external of the group, y two distinct heads ; one, large and superficial, is derived from per part of the inner condyle of the humerus, and from the n tendon above mentioned ; also from the fascia and the inter- ar septum on its inner side. The second head, a thin fasciculus placed, comes from the inner margin of the coronoid process, and e other at an acute angle. The fleshy belly thus formed proceeds ls and downwards, and ends in a flat tendon which turns over ius, and is inserted into a rough impression at the middle of the rface of that bone.

*ons.*—The pronator teres is placed superficially in the greater part of its but towards its insertion it is crossed by the radial artery and nerve, and nator longus muscle. The ulnar border is in contact with the flexor lialis and flexor sublimis digitorum : the radial border forms the inner y of the angular space at the bend of the arm, in which are placed the vessels, the median nerve, and the tendon of the biceps muscle. The teres lies over the brachialis anticus and the radial origin of the flexor digitorum ; the ulnar artery passes behind the whole muscle, and the nerve between its two heads.

*ies.*—The coronoid head is sometimes absent. In other cases the muscle nged further than usual by a slip rising from the intermuscular above the inner condyle of the humerus, or from the supracondylar when that is present. This peculiarity is sometimes associated with a n the direction of the brachial artery. An additional head of origin from s or from the brachialis anticus has also been observed.

**lexor carpi radialis** muscle arises from the inner condyle by mon tendon, from the fascia of the forearm, and from the inter- ar septa placed between it and the pronator teres on one side, the s longus on the other, and the flexor sublimis posteriorly. The bres end a little below the middle of the forearm in a flat tendon, ccupies a special compartment in the outer part of the anterior ligament of the wrist, and running through a groove in the um, to which it is bound by a thin fibrous sheath lined by a l membrane, is inserted into the base of the second metacarpal small slip being generally sent to the base of the third.

*ons.*—The muscle lies immediately under the fascia until its tendon neath the annular ligament. In the lower half of the forearm the radial placed to the outer side of the tendon.

*ies.*—At its origin this muscle has been observed receiving an additional a the tendon of the biceps, the semilunar fascia, the coronoid process of , or the oblique line of the radius. Its insertion is subject to frequent , taking place partly into the annular ligament, the trapezium, or into th metacarpal bone as well as the second and third.

The **palmaris longus**, the smallest muscle of this group, is placed between the flexores carpi radialis and ulnaris, resting on the flexor sublimis: it arises from the inner condyle, the fascia and the intermuscular septa, forming a small muscular belly, which soon ends in a long slender tendon, inserted into the palmar fascia near the middle of the wrist, and sometimes sending a slip to the short muscles of the thumb.

Fig. 165.

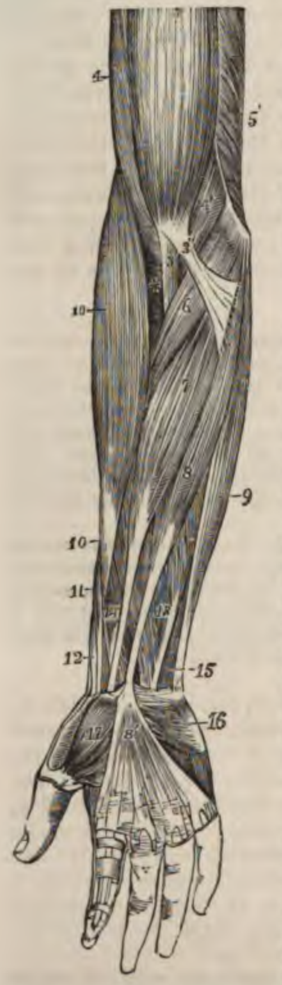


Fig. 165.—SUPERFICIAL MUSCLES OF THE FOREARM AND HAND, SEEN FROM THE FRONT. (A. T.) ⅓

3, biceps; 3′, its tendon of insertion; 3″, its aponeurotic slip; 4, brachialis anticus; 4′, its inner and lower portion; 5′, inner head of the triceps; 6, pronator radii teres; 7, flexor carpi radialis; 8, palmaris longus, passing at 8′ into the palmar aponeurosis; 9, flexor carpi ulnaris; 10, 10, supinator longus; between 10 and 3, +, supinator brevis; 11, extensor ossis metacarpi pollicis; 12, extensor primi internodii; 13, lower part of the flexor sublimis digitorum; 14, flexor longus pollicis; 15, small part of the flexor profundus digitorum; 16, palmaris brevis, lying on the muscles of the little finger; 17, abductor pollicis.

*Varieties.*—This is probably the most variable muscle in the body. It is wanting to the extent of about ten per cent. of the bodies examined. It is subject to many variations of form; *e.g.*, the fleshy fibres may occupy the middle of the muscle, which then commences and ends by an elongated tendon; or the muscular structure may be placed towards the lower end, the upper part being tendinous; or the whole muscle may be reduced to a mere tendinous band. It is sometimes represented by a slip from the flexor carpi ulnaris or flexor sublimis digitorum. Occasionally there are two long palmar muscles, one having the ordinary shape, while the other has one of the forms above referred to. An additional origin has been seen from the coronoid process, or from the radius. Among the varieties that have been observed in its mode of termination are: insertion, partial or complete, into the fascia of the forearm, into the tendon of the flexor carpi ulnaris and the pisiform bone, into the scaphoid, and into the muscles of the little finger.

The **flexor carpi ulnaris**, the innermost muscle of the superficial group, arises by two heads, the one of which forms the hindmost part of the common tendon from the inner condyle of the humerus, the other is attached to the inner side of the olecranon, and to the posterior border of the ulna for two thirds of its length, by an aponeurosis which is inseparably connected with the investing aponeurosis of the limb. The muscular fibres, passing downwards and forwards from this long line of origin, terminate in a tendon which descends along the anterior margin of the muscle, and is inserted into the pisiform bone: this tendon is prolonged, by means of ligamentous structures, to the fifth metacarpal and unciform bones, as well as to the annular ligament.

*Relations.*—This muscle rests on the flexor profundus digitorum. The ulnar nerve and the posterior ulnar recurrent artery pass between the two heads of origin and the nerve is then covered by the muscle as far as the wrist, as is also the ulnar artery below the middle of the forearm.

The **flexor sublimis digitorum** or **flexor perforatus**, the superficial flexor of the fingers, is a broad flat muscle placed behind the preceding muscles. It arises from the inner condyle by the common tendon, and the fibrous septa common to it and the other muscles; from the internal lateral ligament; from the inner margin of the coronoid process; and by a thin flat portion from the oblique line and part of the anterior border of the radius. It is divided inferiorly into four parts, ending in as many tendons, which pass to be inserted into the second phalanx of each of the four inner digits. These tendons pass under the annular ligament of the wrist in pairs; the anterior pair consisting of those for the middle and ring fingers, the posterior of those for the index and little fingers. That for the little finger is much smaller than the others.

In the palm of the hand the tendons diverge, and each, accompanied by a tendon of the flexor profundus, enters a fibrous sheath which binds both tendons down to the palmar surface of the phalanges. Opposite the first phalanx the tendon of the flexor sublimis divides into two parts, which fold closely round the tendon of the deep flexor, and are reunited by their margins behind it: the two portions of the tendon thereafter separating, pass to be inserted one on each side into a ridge at the middle of the lateral border of the second phalanx.

*Relations.*—In the forearm the flexor sublimis is for the most part concealed by the pronator teres, flexor carpi radialis and palmaris longus; but between the last muscle and the flexor carpi ulnaris a narrow strip is superficial from the internal condyle down to the annular ligament. Its radial origin is crossed by the radial artery. It rests on the flexor longus pollicis and flexor profundus digitorum, the median nerve, and the ulnar artery. In the palm of the hand, its tendons are covered by the palmar fascia, the superficial palmar arterial arch, and the branches of the median nerve; and they lie in front of the accompanying tendons of the flexor profundus.

*Varieties.*—The radial origin of the flexor sublimis is sometimes wanting. The body of the muscle is occasionally subdivided, so that each of the four tendons has a distinct muscular belly; this happens most frequently with the radial and the little finger parts. The tendon to the little finger is sometimes absent. A muscular slip is frequently given from this muscle to the flexor profundus, or to the flexor longus pollicis.

The DEEP-SEATED MUSCLES of the front of the forearm are the flexor profundus digitorum, flexor longus pollicis, and pronator quadratus.

The **flexor profundus digitorum**, or **flexor perforans**, a large and thick muscle, arises from the inner and anterior surfaces of the ulna for three-fourths of its length; from the ulnar half of the interosseous membrane for the same distance; and from the aponeurosis attaching the flexor carpi ulnaris to the ulna. It divides inferiorly into four tendons, only one of which, that for the index finger, is distinct from the others above the wrist—the rest being connected together as far as the palm. In the palm the tendons, as they diverge, give origin to the lumbricales muscles. In front of the fingers they are bound to the first and second phalanges by the sheath common to them and the perforated tendons. Opposite the first phalanx, the tendon of each finger passes through the opening formed for its transmission in the tendon of the flexor sublimis, and it is inserted into the base of the last phalanx.

*Relations.*—The upper extremity of the flexor profundus embraces the insertion of the brachialis anticus. In the forearm the muscle is covered by the flexor carpi ulnaris and flexor sublimis digitorum, and on its surface lie the median nerve and the ulnar vessels and nerve. The external border is adjacent to the flexor longus pollicis, from which it is separated on the interosseous membrane by the anterior interosseous vessels and nerve.

Fig. 166.

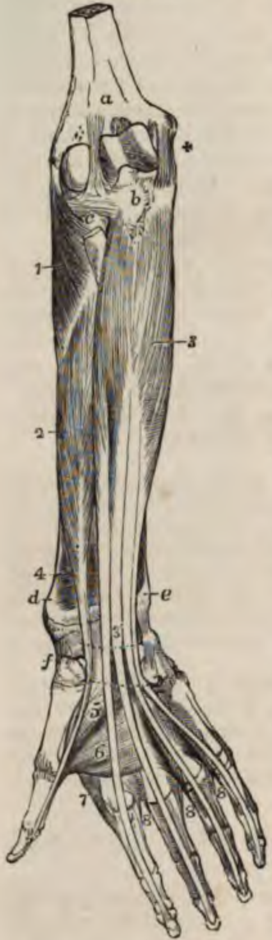


Fig. 166.—Deep anterior muscles of the forearm. (A. T.) ¼

The superficial muscles of the forearm and hand, together with the lumbricales, have been removed, and the place of the anterior annular ligament of the carpus is marked by two dotted lines. *a*, surface of the humerus above the coronoid fossa; *b*, coronoid process of the ulna; *c*, head of the radius covered by the orbicular ligament; +, internal lateral ligament of the elbow-joint; *d*, lower end of the radius; *e*, that of the ulna; *f*, scaphoid and trapezium bones; 1, supinator brevis; 2, flexor longus pollicis; 3, flexor profundus digitorum; 3′, its four tendons, where they are about to pass under the annular ligament; 4, pronator quadratus on the lower part of the radius; 5, deep part of flexor brevis pollicis; 6, adductor pollicis; 7, first dorsal interosseous muscle; 8, in the second space, is placed between the first palmar and the second dorsal interosseous muscles; in the third space, between the third dorsal and the second palmar; in the fourth space, between the fourth dorsal and the third palmar. (For the lumbricales, see figs. 167 and 172.)

The **lumbricales** muscles are four tapering fleshy fasciculi, passing from the tendons of the flexor profundus to the tendons of the common extensor. Each muscle rises by fleshy fibres from the outer or radial border of one of the deep flexor tendons, and in the case of the two inner muscles also from the ulnar border of the second and third, and proceeding downwards and then backwards on the radial sides of the fingers, each is inserted into the expansion of the extensor tendon on the dorsal aspect of the metacarpal phalanx.

*Varieties.*—The flexor profundus often presents varieties in its origin, deriving fibres from the radius in some instances, a distinct slip from the coronoid process of the ulna in others, and more rarely from the inner condyle of the humerus. It is not unfrequently connected with the flexor sublimis, or with the flexor longus pollicis. The slip from the coronoid process constitutes in numerous cases an accessory or supplemental muscle which joins very variously one or more of the perforating tendons.

Varieties of the lumbricales muscles are of frequent occurrence. Their number is sometimes diminished to three, and in rare instances is increased to five or six. The destination of one or two of them is often changed, and one finger (most frequently the middle or ring) has sometimes two inserted into it. Lastly, one muscle may be inserted into two fingers. The fourth has been observed to take the place of the fourth perforating tendon of the flexor profundus.

*Synovial bursa.*—The tendons of both the superficial and deep flexors, as well as the median nerve, are surrounded beneath the annular ligament by a large and loose synovial bursa, which extends upwards to the level of the radio-carpal articulation, and downwards to a little beyond the bases of the metacarpal bones, being prolonged farther on the little finger tendons than on the others. According to Max Schüller (deutsche med. Wochensch. 1878) this bursa is double, the sheath investing the tendons of the two ulnar fingers being separated by a longitudinal partition from that of the index and middle finger tendons. The latter division communicates opposite the upper border of the annular ligament, by a small aperture, with the synovial sheath of the flexor longus pollicis tendon.

Fig. 167.

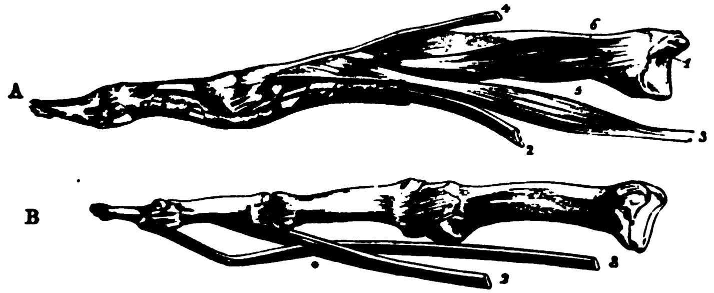


Fig. 167.—Bones of two fingers, with the insertions of the tendons. (R. Quain.) ½

In A, the tendons of the flexor muscles are bound to the bones by the fibrous sheath. In B, the sheath has been removed, as well as the vincula accessoria; 1, metacarpal bone; 2, tendon of the flexor sublimis; 3, tendon of the flexor profundus; *, perforation of the sublimis by the profundus tendon; 4, tendon of the extensor communis digitorum; 5, lumbricalis muscle; 6, one of the interosseous muscles.

The *sheaths of the flexor tendons*, by which they are bound down to the fingers, are formed opposite the shafts of the first and second phalanges by strong tendinous-looking bands of transverse fibres, *vaginal ligaments*, attached to the rough margins of the palmar surfaces of the phalanges. Opposite the joints, flexion is allowed by the substitution for those bands of a thin membrane, strengthened by oblique decussating fibres. The tendinous sheath has a synovial lining, which gives a separate investment to each tendon.

The synovial membrane forms small folds (vincula accessoria tendinum) between the tendons and the bones. There are two sets of these; the one, *ligamenta brevia*, broad and membranous, passing between the tendons near their insertion and the lower part of the phalanx immediately above; the other, *ligamenta longa*, slender and less constant bands, joining the tendons at a higher level. Contained in the ligamentum breve of the deep flexor is a small band of yellow elastic tissue (vinculum subflavum), which stretches from the tendon to the head of the second phalanx, and may assist in drawing down the tendon after flexion of the fingers (J. Marshall, Brit. and For. Med. Chir. Rev. 1853).

The **flexor longus pollicis** muscle, placed side by side with the flexor profundus digitorum, arises from the anterior surface of the radius, extending from the oblique line to the edge of the pronator quadratus;

from the adjacent part of the interosseous membrane; and in the majority of instances it receives also a distinct fleshy and tendinous slip, springing in common with the flexor sublimis digitorum from the inner condyle or the coronoid process. The muscle ends in a tendon which passes behind the annular ligament of the wrist close to the trapezium, turns outwards between the two heads of the flexor brevis and between the sesamoid bones, and, entering a canal similar to those of the other flexor tendons, is finally inserted into the base of the second phalanx of the thumb.

As the tendon of the muscle passes under the annular ligament it is surrounded by a synovial bursa, which is continued below into the digital sheath, and communicates above with the bursa of the common flexor tendons in the manner before mentioned.

*Varieties.*—The flexor longus pollicis is sometimes connected by a slip with the flexor sublimis or profundus, or the pronator teres. A tendon of insertion into the index finger has been observed, as also a slip to the first lumbricalis.

The **pronator quadratus**, placed close to the bones behind the last two muscles, arises from the inner part of the anterior surface of the ulna in its lower fourth; its fibres cross the lower part of the forearm, some transversely and others obliquely, and they are inserted for a slightly shorter distance into the fore part of the radius.

*Varieties.*—The pronator quadratus is subject to varieties, chiefly as follows:—1. It may be entirely absent, but this is rare; 2, it is subdivided into two layers, or occasionally into three; 3, it extends farther upwards on the bones of the forearm than usual; 4, it is prolonged downwards on the carpus, in some cases as a radio-carpal, and in others as an ulno-carpal muscle.

The *radio-carpus* (Fano), or *flexor carpi radialis brevis* (Wood), is an additional small muscle not unfrequently seen, arising from the radius, usually from the anterior border and surface above the pronator quadratus, and very variably inserted below, into the annular ligament, the trapezium, magnum, or some other part of the carpus, or into one or more of the metacarpal bones.

**Nerves.**—The muscles of the pronator and flexor group receive their nerves in greatest part from the median; only one muscle, flexor carpi ulnaris, being wholly, and another, flexor profundus digitorum, in part, supplied from the ulnar nerve. The branches from the median are distributed to the muscles in two sets, the superficial muscles being supplied by branches arising from the trunk near the elbow, the deep muscles, viz., the flexor longus pollicis, the outer half of the flexor profundus and the pronator quadratus, being supplied by its anterior interosseous branch.

### SUPINATOR AND EXTENSOR MUSCLES.

The muscles of this group are, like those of the front of the forearm, divided into a superficial and a deep layer.

The SUPERFICIAL MUSCLES are seven in number, viz., the supinator longus, the extensores carpi radiales longior and brevior, the extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, and anconeus. The last muscle has already been described in connection with the triceps (p. 211).

The **supinator radii longus** muscle (brachio-radialis—Sœmmering) arises from the upper two-thirds of the external supracondylar ridge of the humerus, and from the external intermuscular septum. Its fibres form a thin fleshy mass, which descends on the outer and anterior part of the limb to about the middle of the forearm, where it ends in a flat tendon, which is inserted into an impression on the outer side of the lower end of the radius, near the base of the styloid process.

*Relations.*—This muscle is covered only by skin and fascia, except at its insertion, where two of the extensor tendons of the thumb lie over the tendon. Above, the brachialis anticus is in contact with its inner surface, the musculo-spiral nerve being interposed, and the long radial extensor is beneath it. It forms the outer boundary of the triangular space at the bend of the elbow, and in the forearm it rests upon the supinator brevis, pronator teres, flexor sublimis digitorum, and the radial vessels and nerve.

Fig. 168.

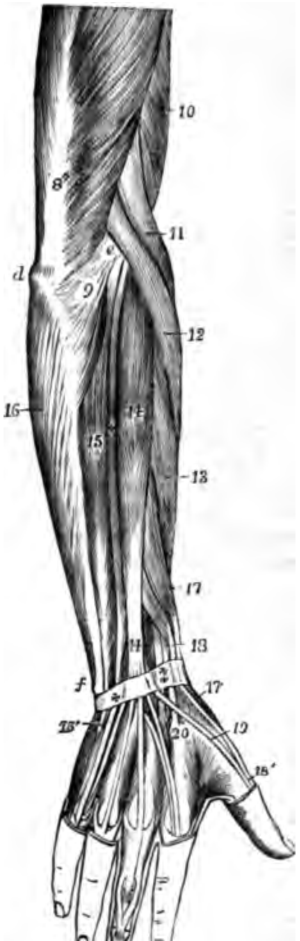


Fig. 168.—SUPERFICIAL MUSCLES OF THE FOREARM AND HAND, SEEN FROM BEHIND. (A. T.) ½

*d*, olecranon; *e*, external condyle; *f*, lower end of ulna; 8", tendon of triceps; 9, anconeus; 10, part of brachialis anticus; 11, supinator longus; 12, extensor carpi radialis longior; 13, ——— brevior; 14, extensor communis digitorum; 15, extensor carpi ulnaris; 15', its insertion into the fifth metacarpal bone; +, between 14 and 15, extensor minimi digiti; 16, origin of the flexor carpi ulnaris by an aponeurosis from the back of the ulna; 17, extensor ossis metacarpi pollicis: 17', its insertion into the first metacarpal bone; 18, extensor primi internodii pollicis; 18', its insertion into the first phalanx; + and ‡, posterior annular ligament; at ‡, the tendons of the long and short radial extensors; at +, the tendon of the extensor minimi digiti; 19, tendon of extensor secundi internodii; 20, is placed on the proximal end of the second metacarpal bone, close to the insertion of the radial extensors of the carpus: in the hand, the dorsal interosseous muscles are shown, and on the middle finger the insertion of the extensor tendon.

*Varieties.*—These are neither great nor numerous in this muscle. One of the commonest is the division of the tendon or lower part of the muscle into two or sometimes three slips, which are inserted either together or at some distance from each other. The supinator longus may also be connected to some of the neighbouring muscles, especially at its origin.

The **extensor carpi radialis longior** muscle arises from the lower third of the external supracondylar ridge of the humerus, and from the external intermuscular septum: a few fibres also spring from the outer side of the common tendon of the extensor muscles. Its muscular belly ends above the middle of the forearm in a flat tendon, which passes, conjointly with that of the following muscle, in the outermost of the grooves on the posterior surface of the radius, and is inserted into the base of the second metacarpal bone. A small bursa lies beneath the tendon at its insertion.

The **extensor carpi radialis brevior** muscle arises from the outer condyle of the humerus by a tendon common to it and the following muscles, from the intervening fibrous septa, from the fascia covering it, and from the external lateral ligament of the elbow joint. Its muscular belly ends in a tendon, which, descending with that of the extensor longior, passes through the same groove of the radius with it, and is inserted into the base of the metacarpal bone of the middle finger. A small bursa is placed under the tendon close to its insertion, and there is occasionally another between the origin of the muscle and the supinator brevis.

*Relations.*—Of the two foregoing muscles the extensor longus is the more superficial. The extensor brevis covers the supinator brevis and the insertion of the pronator radii teres. The tendons of these muscles and that of the supinator longus are crossed obliquely by the extensors of the metacarpal bone and first phalanx of the thumb.

*Varieties.*—The two foregoing muscles are subject to a similar variation in being, one or other of them, split up into two or sometimes three tendons previous to insertion; the tendons of either muscle being inserted into both the second and third metacarpal bones: occasionally a slip passes also to the fourth metacarpal bone. The two muscles have been seen united, so that a single fleshy belly gives off two tendons; and cross slips from one muscle to the other are of frequent occurrence.

An additional muscle, called *extensor carpi radialis accessorius* by Wood, is sometimes met with, rising from the humerus below the extensor carpi radialis longior, and inserted most frequently into the metacarpal bone of the thumb, but sometimes into the abductor pollicis, first dorsal interosseous muscle, or other part. It is represented at times by a slip from the tendon of the extensor longior.

The **extensor communis digitorum** muscle arises from the outer condyle by the common tendon, from the fascia of the forearm, and from the septa between it and the adjoining muscles. In the lower third of the forearm the muscular part ends in four tendons, which pass under the posterior annular ligament, lying in the innermost broad groove on the back of the radius, and diverge as they proceed along the carpus and metacarpus to reach the fingers. Here each is increased by tendinous fibres derived from the lumbricales and interosseous muscles, forming a fibrous expansion which covers the back of the first and second phalanges and terminates upon the third phalanx. It is attached to the second and third phalanges in the following manner. Opposite the first bone the tendon divides into three slips; the central one is much thinner than the others, and is inserted into the base of the second phalanx; the two lateral parts, continuing onwards, join together below and are inserted into the base of the last phalanx. The tendons to the index and little fingers, which are much smaller than the other two, are joined opposite the metacarpo-phalangeal articulations by the special extensor tendons of those digits.

On the back of the hand the four tendons are united by cross slips or vincula. That between the index and middle finger tendons is simply a thin, loose band of transverse fibres, and is not unfrequently wanting. Those on each side of the ring finger tendon are much stronger; one passes obliquely downwards from the third (ring finger) tendon to the second, the other from the fourth tendon to the third. In consequence of this arrangement the three inner fingers are associated in their movements, and the ring finger can not in general be freely extended without also moving the middle one. The tendons are farther bound down over the metacarpo-phalangeal articulations by means of aponeurotic bands, which are given off from the margins of each, and directed forwards by side of the joint, to blend with the palmar ligament of the articulation.

*Varieties.*—The varieties of the extensor communis digitorum resolve themselves chiefly into the following, viz., 1st, the occasional deficiency of one or more of the tendons of insertion, and 2nd, more frequently an increase in their number. This last goes in some instances to the extent of doubling the tendon to each of the fingers, and even of tripling it to one or two of them. More frequently, however, the increase in number of the tendons is limited to the index or little finger alone.

The **extensor minimi digiti** is a slender muscle which is placed between the extensor communis digitorum and the extensor carpi ulnaris, and arises by means of a thin tendon in common with the extensor communis. The tendon in which it ends occupies a groove between the radius and ulna, passing through a special compartment in the annular ligament; on the back of the hand it becomes split into two, the outer division being joined by the fourth tendon of the common extensor, and both parts end in the dorsal expansion of the little finger, in the formation of which it takes by far the greater share.

*Varieties.*—This muscle is subject to an increase in the number of its tendons of insertion, and in a large proportion of the cases the additional tendon is inserted into the ring-finger. The entire absence of the muscle has also been observed.

The **extensor carpi ulnaris**, the most internal of the muscles descending on the back of the forearm, arises from the external condyle of the humerus by the common tendon, from a strong intermuscular septum on its outer side, and from the fascia of the forearm. The belly of the muscle is in its middle third closely bound down to the posterior border of the ulna by the fascia, and it occasionally receives a few additional fibres from this portion of the bone. The fleshy fibres are collected round a tendon which becomes free a little above the wrist, and runs through a special groove in the carpal end of the ulna and a separate sheath in the annular ligament, to be inserted into the tuberosity on the base of the fifth metacarpal bone.

*Varieties.*—This muscle is frequently connected with the abductor minimi digiti. It also sometimes sends a prolongation to the extensor tendons on the back of the little finger, which has been named *ulnaris quinti.*

The DEEP-SEATED MUSCLES on the back of the forearm are five in number, the supinator brevis, the three extensors of the thumb, and the extensor of the index finger.

The **supinator radii brevis** muscle arises from the external lateral ligament of the elbow-joint, from the annular ligament of the radius, and from a depression below the sigmoid cavity of the ulna, extending downwards a short distance along the outer border of the bone. The fleshy fibres derived from these points of attachment, as well as from a tendinous expansion on the surface, which can be followed up to the external condyle, pass obliquely round the upper part of the radius, covering it closely except at the inner side, and are inserted into that bone, for rather more than a third of its length, reaching down to the insertion of the pronator radii teres. It is pierced by the posterior interosseous nerve, which effects a more or less complete division of the muscle into two layers.

The **extensor ossis metacarpi pollicis** muscle (abductor longus pollicis—Albinus) arises from a narrow oblique impression occupying the upper part of the outer division of the posterior surface of the ulna (see p. 92), below the origin of the supinator brevis; from the middle third of the posterior surface of the radius, below the insertion of the same muscle; and from the interosseous membrane between. Thence descending obliquely outwards, it ends in a tendon which passes, in company with the extensor primi internodii pollicis, through the groove on the outer side of the lower extremity of the radius, and is inserted in the base of the metacarpal bone of the thumb.

Fig. 169.

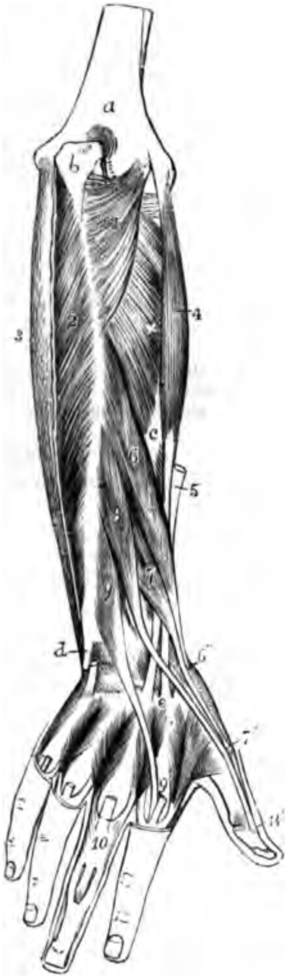


Fig. 169.—Deep posterior muscles of the forearm. (A. T.) ½

*a*, humerus; *b*, olecranon; *c*, radius; *d*, lower part of the ulna, grooved for the tendon of the extensor carpi ulnaris, which is cut short; 1, anconeus; 2, flexor profundus digitorum, exposed by the removal of the aponeurotic tendon of 3, the flexor carpi ulnaris; +, supinator brevis; 4, extensor carpi radialis brevior, and 5, the cut tendon of the extensor carpi radialis longior; *e*, their insertions into the second and third metacarpal bones; 6, extensor ossis metacarpi pollicis; 6′, its insertion into the base of the first metacarpal bone; 7, extensor primi internodii pollicis; 7′, its insertion into the base of the first phalanx; 8, extensor secundi internodii pollicis; 8′, its insertion into the base of the last phalanx; 9, extensor indicis; 9′, its junction with the tendon of the common extensor, which is cut short: in the intermetacarpal spaces the four dorsal interosseous muscles are exposed, the tendons of the common extensor having been removed; and at 10, the insertions of the second and third dorsal interosseous muscles, by a triangular expansion, into the tendon of the extensor communis, as well as the mode of insertion of that tendon into the middle and last phalanges, are shown.

*Relations.*—The upper part of this muscle is concealed by the common extensor, but it becomes superficial below, and together with the next muscle crosses the tendons of the radial extensors of the carpus, conceals the insertion of the supinator longus, and, below the extremity of the radius, crosses the radial artery.

The **extensor primi internodii pollicis** muscle lies close to the lower border of the extensor ossis metacarpi, and is much smaller than that muscle; it arises from the interosseous ligament and a small part of the radius below the middle of the forearm; its tendon accompanies that of the extensor ossis metacarpi through the same compartment of

ular ligament, and passes on to be inserted into the proximal end
rst phalanx.

**extensor secundi internodii pollicis** muscle, much larger
extensor primi internodii, which it overlaps, arises immediately
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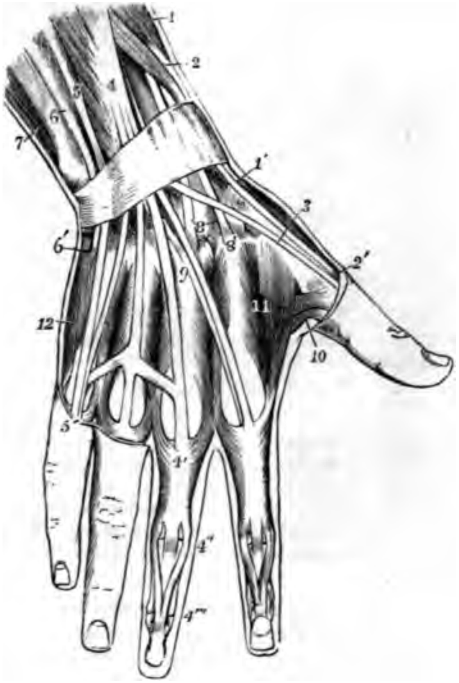
r surface of the ulna for its middle third or more, and from the
ous membrane for about an inch opposite the lower part of the

Fig. 170.



—Superficial mus-
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e, points to the insertion of the extensor carpi radialis longior; 9, tendon of
ndicis; 10, small part of the adductor pollicis, and inner head of the flexor
licis; 11, first dorsal interosseous or abductor indicis: in the other three inter-
aces are seen in succession, from the radial side inwards, the insertion of the
ar, second dorsal, third dorsal, second palmar, fourth dorsal, and third palmar
s muscles; 12, abductor minimi digiti.

tachment. Its fibres end in a tendon which passes through a
compartment of the annular ligament, occupying the narrow
groove in the middle of the posterior surface of the carpal end of
us, and is inserted into the base of the terminal phalanx of the

*ies.*—The extensor muscles of the thumb are subject to considerable
s, and if all the three muscles be included they seem to occur as often
e out of every six subjects dissected. The most common occur in the
ossis metacarpi, and consist in more or less cleavage of the muscle or
n into separate parts. The insertion of the distinct tendons takes place
ubly into the first metacarpal bone, or in part into the trapezium, or

into the abductor or opponens pollicis muscles. The extensor primi internodii is sometimes absent, being, as it were, fused with the extensor ossis metacarpi, in other cases it is more or less united with the extensor secundi internodii pollicis. An occasional variety, representing a muscle normally existing in the dog and many carnivora, is the presence of an additional extensor between the indicator and the extensor secundi internodii pollicis, with a double tendon and insertion into both digits.

The **extensor indicis** or indicator muscle arises from the outer division of the posterior surface of the ulna for a variable extent below the extensor secundi internodii, and slightly from the interosseous membrane at its lower part. The tendon passes with the common extensor through a compartment of the annular ligament, comes in contact with the tendon from that muscle destined for the index finger, and unites with it to form the expansion already described.

Fig. 171.

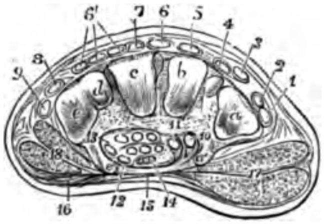

Fig. 171.—TRANSVERSE SECTION OF THE RIGHT HAND BETWEEN THE CARPUS AND METACARPUS. (A. T.) ½

*a*, *b*, *c*, *d*, *e*, articular surfaces of the trapezium, trapezoid, magnum and unciform bones; *a′*, palmar ridge of the trapezium; *e′*, unciform process; between *a′* and *e′*, the cut edge of the annular ligament, sending a process towards the trapezoid at 11, by which the tendon of the flexor carpi radialis is enclosed in the groove of the trapezium; 1, tendon of the extensor ossis metacarpi pollicis; 2, extensor primi internodii; 3, extensor secundi internodii; 4, extensor carpi radialis longior; 5, brevior; 6, index finger tendon of extensor communis digitorum; 6′, remaining tendons; 7, extensor indicis; 8, extensor minimi digiti; 9, extensor carpi ulnaris; 10, flexor carpi radialis; 11, flexor longus pollicis; 12, the first on the ulnar side of the tendons of the flexor sublimis digitorum; 13, the same of the flexor profundus; 14, median nerve; 15, the palmar aponeurosis stretched across the annular ligament; 16, palmaris brevis; 17, short muscles of the thumb; 18, muscles of the little finger.

*Varieties.*—This muscle is but rarely absent. Its tendon is frequently double, and one of the parts may pass to the middle finger, leading to the formation of an *extensor medii digiti*, which may occur also as a distinct muscle arising from the ulna or posterior ligament of the wrist-joint below the indicator. Less frequently an *extensor brevis digitorum manus* is present, arising from the back of the wrist-joint, or from the carpus, or from the bases of some of the metacarpal bones, and sending tendons to one, two, or three fingers. Intermediate forms between these two muscles are also met with.

**Nerves.**—The anconeus, supinator longus, and extensor carpi radialis longior receive branches directly from the musculo-spiral trunk; the remaining muscles of this group are supplied by the posterior interosseous division of that nerve.

## MUSCLES AND FASCIÆ OF THE HAND.

FASCIÆ.—The **fascia of the dorsum of the hand,** a thin layer composed mainly of transverse fibres, is prolonged downwards from the lower border of the annular ligament over the extensor tendons, and blends with these on the fingers. Deeper than the extensor tendons thin aponeuroses are stretched over the intermetacarpal spaces, being attached laterally to the bones, and covering the dorsal interosseous muscles to which they are firmly adherent.

The **fascia of the palm** consists of a central part which is thick and rong, and of two lateral portions, which are very thin and cover the ort muscles of the thumb and little finger. The central portion is at commonly referred to under the name of the *palmar fascia.* onsisting principally of longitudinal fibres which are in largest part ontinued from the tendon of the palmaris longus, others however pringing from the front of the annular ligament, it is narrow above nd becomes expanded and thinner below. Here it divides into four rocesses which pass to the bases of the several fingers, and join the ommencement of the digital sheaths, sending some fibres also to the ntegument at the clefts of the fingers, and to the superficial transverse igament. From the sides of these processes, moreover, offsets are sent ackwards to be attached to the transverse metacarpal ligament opposite he lateral margins of the heads of the metacarpal bones, and thus above ach finger a short canal is formed in which the flexor tendons run. In the intervals between the processes some deeper transverse fibres make their appearance, covering the lumbricales muscles and the digital vessels and nerves. At the lower margin of the palm a superficial band of transverse fibres, which stretches across the roots of the four fingers, being contained in the folds of skin at the upper ends of the clefts, is known as the *superficial transverse ligament of the fingers.* There is also deeply placed in the palm a thin layer of fascia which covers the interosseous muscles, and dipping between them is attached to the palmar ridges of the metacarpal bones, while inferiorly it becomes continuous with the transverse metacarpal ligament. From the deep surface of the palmar fascia a thin septum is sent backwards on each side between the flexor tendons and the thumb and little finger muscles respectively, and these, joining the fascia covering the interosseous muscles, complete a sheath in which the tendons are contained in their passage through the palm.

*Cutaneous ligaments of the phalanges.*—Under this name Professor Cleland has described some fibrous bands which spring from the edges of the phalanges and are inserted into the skin of the sides of the fingers, and which serve the purpose of retaining the skin in position during flexion of the joints (Journ. Anat. xii. 526).

Muscles.—Besides the tendons of the long muscles and the lumbricales already described, there are placed in the hand one superficial muscle called palmaris brevis, the short muscles of the thumb and little finger, and the interosseous muscles.

The **palmaris brevis** (fig. 165, 16) is a thin flat subcutaneous muscle, which arises from the inner margin of the palmar fascia and the annular ligament; its fibres pass transversely inwards, and are inserted into the skin along the inner border of the palm.

*Relations.*—The palmaris brevis crosses the muscles of the little finger and covers the ulnar vessels and nerve.

Muscles of the thumb.—The fleshy mass which forms the *thenar eminence*, or ball of the thumb, consists of four muscles.

The **abductor pollicis** muscle, superficial and flat, arises mainly from the front of the annular ligament, a few of the outer fibres being attached sometimes to the ridge of the trapezium or the tubercle of the scaphoid; proceeding downwards and outwards, it is inserted by a tendon into the radial border of the first phalanx of the thumb at its base.

The **opponens pollicis** muscle, placed behind the abductor, arises from the annular ligament and from the outer side of the ridge of the trapezium, and is inserted into the whole length of the metacarpal bone of the thumb at the radial border, as well as the adjoining part of the palmar surface.

Fig. 172.

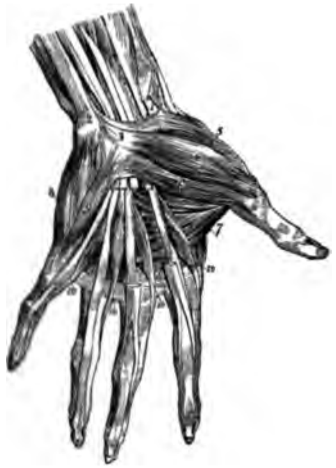

Fig. 172.—Muscles and tendons of the palmar aspect of the hand. ½

Portions of the tendons of the superficial flexor have been cut away to show those of the deep flexor and the lumbricales. 1, tendon of the flexor carpi radialis, cut short; 2, tendon of the flexor carpi ulnaris, inserted into the pisiform bone; 3, anterior annular ligament; 4, abductor pollicis; 5, opponens pollicis; 6, 6, flexor brevis pollicis; 7, adductor pollicis; 8, abductor minimi digiti; 9, flexor brevis minimi digiti; 10, lumbricales.

The **flexor brevis pollicis** muscle arises in two parts, a superficial and a deep. The superficial part, much the smaller, is attached to the outer two-thirds of the annular ligament at its lower border: the deep part is attached in several slips to the trapezium, to the sheath of the flexor carpi radialis, to the os magnum, and to the bases of the second and third metacarpal bones. From these origins two strong masses of fibres proceed, which are known as the outer and inner heads of the muscle, and these, becoming tendinous, are inserted into the sides of the base of the first phalanx of the thumb; the outer head is also joined by a considerable fasciculus from the deeper origin: the inner head is inserted conjointly with the adductor pollicis. In each of the tendons of insertion a sesamoid bone is developed, which plays over the head of the first metacarpal bone. The tendon of the long flexor lies between the two origins, and grooves the surface of the muscle as it passes between the heads of insertion.

Fig. 173.

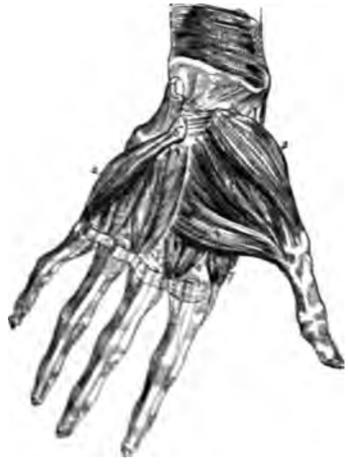

Fig. 173.—Deep muscles of the palm of the hand. ½

The abductor pollicis and abductor minimi digiti, together with the anterior annular ligament and the deep flexor tendons in the palm, have been removed; in the fore-finger the tendons of both the superficial and deep flexors remain; in the other fingers the tendons of the superficial flexor have been removed. 1, pronator quadratus muscle; 2, opponens pollicis; 3, flexor brevis pollicis; 4, adductor pollicis; 5, opponens minimi digiti; 6, unciform bone; 7, 8, interosseous muscles.

The **adductor pollicis** muscle arises from the ridge on the lower two-thirds of the palmar aspect of the third metacarpal bone, and is inserted into the base of the first phalanx of the thumb along with the inner tendon of the short flexor. The deep palmar arterial arch passes between this muscle and the deep origin of the flexor brevis.

MUSCLES OF THE LITTLE FINGER.—The fleshy mass at the inner border of the hand (*hypothenar eminence*) consists of three muscles passing to the little finger.

The **abductor minimi digiti** muscle arises by tendinous fibres from the lower border and inner surface of the pisiform bone, and is inserted into the base of the first phalanx of the little finger on the ulnar border, a slip being sent to the extensor tendon on the back.

The **flexor brevis minimi digiti,** separated at its origin from the abductor muscle by a small interval through which pass the deep palmar branches of the ulnar nerve and artery, arises from the front of the annular ligament, and from the tip of the hooked process of the unciform bone, and is inserted into the base of the first phalanx of the little finger, in common with the preceding muscle. This muscle is sometimes absent, or becomes incorporated with the abductor.

The **opponens minimi digiti** muscle arises from the annular ligament and the unciform process, and is inserted into the ulnar border of the fifth metacarpal bone in all its length.

The INTEROSSEOUS MUSCLES occupy the intervals between the metacarpal bones. They are seven in number, all of them more or less visible from the palmar aspect, and they are divided into two sets, viz., those which are best seen on the dorsal aspect of the metacarpus, and those which are seen only in the palm. Their disposition is most easily understood by reference to their action.

The **dorsal interosseous** muscles abduct the fingers from the middle line of the hand; they are four in number, one in each of the spaces between the metacarpal bones, and are numbered from without inwards. Each muscle arises from both the metacarpal bones between which it is placed, but most extensively from that supporting the finger upon which it acts, and the fibres converge pennately to a common tendon in the middle. Each terminates in a tendon which is inserted partly into the base of the first phalanx, and partly into the tendon of the extensor muscle on the dorsum of the same part of the finger. Two of the muscles are inserted into the middle finger and draw it to either side; of the remaining two one passes to the radial side of the index finger, and the other to the ulnar side of the ring finger; they withdraw those fingers from the middle line of the hand.

The first dorsal interosseous muscle or *abductor indicis* is larger than the others; its outer and larger head of origin arises from the proximal half of the ulnar border of the first metacarpal bone, the inner is attached to the whole length of the second metacarpal bone, and between these heads there is left superiorly an interval wider than in the other dorsal interosseous muscles.

*Relations*—Between the heads of the abductor indicis the radial artery passes forwards to the palm of the hand; between those of the other dorsal interosseous muscles, small perforating arterial branches are transmitted.

The three **palmar interosseous** muscles are adductors, drawing the index, ring, and little fingers towards the middle line of the hand. They are visible only on the palmar aspect of the hand, each one arising from the corresponding lateral surface of the body of the metacarpal bone of the finger on which it acts: they terminate, like the dorsal muscles, in small tendons inserted partly into the bases of the first phalanges at the side, and partly into the extensor tendons. The first palmar interosseous muscle belongs to the ulnar side of the index finger; the others are placed on the radial sides of the ring and little fingers.

Fig. 174.

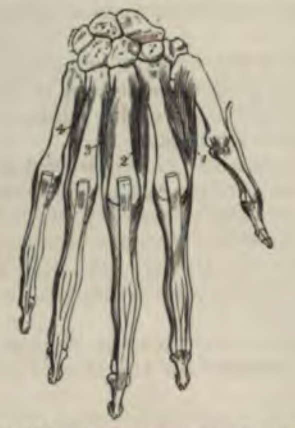

Fig. 175.

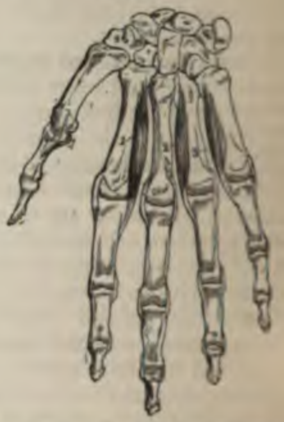

Fig. 174.—THE RIGHT HAND FROM BEHIND, SHOWING THE DORSAL INTEROSSEOUS MUSCLES (R. Quain). 2/7

The tendons of the extensor muscles have been removed as far as the distal ends of the metacarpal bones. 1, 2, 3 and 4, the dorsal interosseous muscles, in order from the radial side inwards; their expanded insertion in connection with the extensor tendons, is shown upon the first phalanges.

Fig. 175.—THE RIGHT HAND FROM BEFORE, SHOWING THE PALMAR INTEROSSEOUS MUSCLES (R. Quain). 2/7

1, 2, 3, refer to the first, second, and third palmar interosseous muscles.

**Varieties of the short muscles of the hand.**—The palmaris brevis varies greatly in the strength of its muscular fibres, and somewhat also in their length and direction. It is seldom entirely absent (in the proportion of one in forty-five out of six hundred dissections by Macalister). It is sometimes found running into the flexor minimi digiti.

The abductor pollicis is often divided into an outer and an inner part—a condition described by Sœmmerring as normal. Accessory slips are also found joining the muscle; frequently from the tendon of the extensor ossis metacarpi pollicis or palmaris longus, more rarely from the extensor carpi radialis longior (or accessorius), from the styloid process or opponens pollicis. Another slip, which is frequently present, springs from the skin over the upper part of the thenar eminence.

The flexor brevis pollicis is a variable muscle, especially in its deeper belly, which shows a tendency to become more or less connected with the adductor pollicis; and in the same manner the latter muscle is subject to variation in its extent in inverse proportion to that of the flexor brevis.

The abductor minimi digiti is found occasionally divided into two or even three slips; in other cases it is united with the flexor brevis. An accessory head is not unfrequently present, arising from the tendon of the flexor carpi ulnaris, the annular ligament, the fascia of the forearm, or tendon of the palmaris longus. In some cases the additional head arises a considerable distance above the wrist from the intermuscular fascia, under either the flexor carpi ulnaris or flexor carpi radialis, and passing downwards covers the ulnar artery to a greater or less extent, ending in the abductor or occasionally in the flexor minimi digiti. This long head is regarded by Macalister as a derivative of the palmaris longus.

The opponentes muscles are subject to varieties chiefly affecting their extent, and the degree of their union with or separation from the neighbouring muscles.

The interosseous muscles present some variations but not of any great magnitude. They are occasionally double in one or more of the spaces. A palmar interosseous muscle of the thumb is frequently present, and according to Henle is regular, in the form of a muscular slip springing from the first metacarpal bone in front of the abductor indicis, and joining below the inner head of the flexor brevis pollicis. The arrangement which usually exists in the foot, and which is peculiar to man, has also been observed to occur in the hand.

**Nerves of the muscles of the hand.**—The median nerve supplies branches to the abductor pollicis, the flexor brevis and opponens immediately below the annular ligament, and to the first two lumbricales muscles from the third and fourth digital nerves respectively. The ulnar nerve, besides giving a twig to the palmaris brevis, furnishes by its deep palmar division branches to the muscles of the little finger, the two internal lumbricales, all the interosseous muscles, the adductor, and the inner head of the flexor brevis pollicis.

## ACTIONS OF THE MUSCLES OF THE FOREARM AND HAND.

The muscles of the forearm may be distinguished according to their actions as pronators and supinators, flexors and extensors of the wrist, and long flexors and extensors of the fingers; those of the hand are flexors and extensors, adductors, abductors and opposers of the fingers; the terms adduction and abduction being here used with reference to the middle line of the hand.

*Pronation* is mainly effected by the pronator teres and pronator quadratus: the flexor carpi radialis also contributes slightly to this movement. The pronator teres is fitted to flex the elbow when pronation has been completed, or when it is prevented by antagonistic muscles, and in this action it receives assistance from the other muscles arising from the internal condyle.

*Supination* is effected principally by the supinator brevis, together with the biceps, the supinator longus having but little influence upon this action. The latter muscle is essentially a *flexor of the elbow*, acting, however, only after that movement has been begun by other muscles. The radial extensors of the wrist assist also in flexing the elbow; the remaining muscles arising from the external condyle aid in extending that joint.

*Flexion of the wrist* is produced by the radial and ulnar flexors of the carpus, and is aided by the flexors of the fingers when the action of those muscles on the fingers is either completed or is opposed by any resistance, as when the over-extended hand is pressed against a surface in pushing, or in the support of the body. *Extension of the wrist*, in a similar manner, is accomplished not only by the three muscles specially devoted to that function, but also by the extensors of the fingers. The lateral movements of the wrist are produced by the same muscles, acting in different combinations: *abduction* by the radial flexor and extensors, assisted by the extensors of the thumb; and *adduction* by the ulnar flexor and extensor.

To ensure the efficient action of the long extensor and flexor muscles of the fingers it is necessary that there should be simultaneous action of the flexors and extensors of the wrist respectively; for the wrist-joint must be fixed backwards by its extensors in order that the long flexors of the fingers may act, and the wrist must be fixed forwards by its flexors in order that the long extensors may act upon the fingers.

The *flexor sublimis digitorum* and the *flexor profundus* bend respectively the second and the third phalanges of the fingers, while the *extensor communis* extends chiefly the first phalanx. The four *lumbricales*, on the other hand, and the

are visible only on the palmar asp
from the corresponding lateral surf
bone of the finger on which it a
muscles, in small tendons inserte

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This
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The
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ments made in forming
has been well known
lumbricales, but it has recently
interossei by the electro-physiological
of Duchenne, whose interesting work*
and other muscular movements.
it is farther to be observed that
of the second and third phalanges
rally exercise an abducting or adducting
away from or towards the middle line of the
their respective insertions; and thus the
abductors of the index, middle and ring fingers.
muscles are adductors of the index, ring, and

Fig. 174.

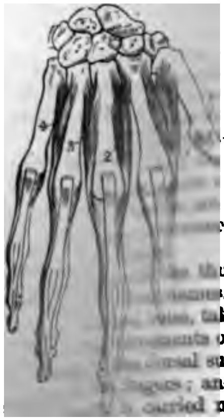

Fig. 174.—

The tendons
of the me
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Fig.

umb produce for the most part the several move-
these movements, in consequence of the position
ke place in directions which differ from those of
of the fingers. Thus, extension, being movement
urface of the digit, occurs in nearly the same plane
d in abduction, the thumb moving in the direction
more forwards than outwards. Opposition is pro-
action of the *flexor brevis* and *opponens* muscles.
withdrawn from the others by its *abductor*, as the ring
rom the middle finger by the fourth dorsal interosseous
*ctor* acting with the long flexors, likewise assists the *flexor*
first phalanx firmly down in grasping. The *opponens* draws
metacarpal bone, so as to render the hand narrower and deepen
palm.
*is longus* has the effect of tightening the palmar fascia, the
draws up the integument on the inner side, so as to increase the
eminence.

## SCLES AND FASCIÆ OF THE LOWER LIMB.

scles which pass between the trunk and the lower limb, viz.,
pyriformis, and part of the gluteus maximus, are so few in
and so intimately connected with others belonging strictly to
that it is unnecessary to describe them as a distinct group, as
done in the case of the more numerous and considerable
which attach the upper limb to the trunk.

### FASCIÆ OF THE HIP AND THIGH.

The **superficial fascia** of the lower limb is similar to and continuous
that of other parts of the body. Over the gluteal region it is very
k, and assists in forming the prominence of the buttock. On the
nt of the thigh it covers the lymphatic glands and the superficial
sels and nerves; it passes freely over Poupart's ligament, becoming
tinuous with the subcutaneous layer of the abdominal fascia, and
ernally it passes into the dartos tunic of the scrotum and into the

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* Dr. G. B. Duchenne, "Physiologie des Mouvements, &c.," Paris, 1867.

rineum. In the [illegible]
olar tissue, placed [illegible] fourth of
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the **thigh** or **fascia lata** is a [illegible]
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two layers, one of which passes on the sup[illegible]
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yers unite at its lower and external borders. Over the [illegible]
nter, where the layers unite externally, and where also the [illegible]
h thickened, the greater number of the fibres of the mus[illegible]
d between the layers. The thickened portion of the fascia [illegible]
ed downwards on the outside of the thigh, from the crest of [illegible]
to the outer tuberosity of the tibia and the head of the fib[illegible]
*io-tibial band* consists of dense glistening parallel fibres, and abou[illegible]
ction of the upper and middle thirds of the thigh it receives al[illegible]
ertion of the tensor vaginæ femoris muscle. On the rest of the thigh
cia lata varies in thickness. It is thinnest in the upper and inner
the thigh, where it covers the adductor muscles. At the knee it
iderably strengthened on each side of the patella by tendinous
ions given off from the lower parts of the vasti muscles, and
in forming the capsular investment of the joint. This part of
cia is firmly attached to the head of the tibia and to the lateral
s of the patella, but a superficial layer is given off which extends
e front of the latter bone, a synovial bursa of considerable size
nterposed. A second smaller bursa is placed immediately under
n covering the patella, and the cavities of the two are sometimes
ous through an aperture in the aponeurosis. Other small bursæ
unfrequently present over the patella or its ligament, or over the
e of the tibia. Posteriorly the fascia is continued uninterruptedly
e hamstring muscles and the popliteal space into the fascia of

he front of the thigh, a little below and external to the inner end of
t's ligament, is placed the *saphenous opening*, an aperture in the
ata through which the internal saphenous vein passes to join the
l vein, and which receives special attention from its being the
f exit of femoral hernia. The outer part of this opening lies in
f the femoral artery, and is bounded externally by a crescentic
, the *falciform border*, which crosses the surface of the infundi-
m sheath of the femoral vessels. This margin in the middle of
nt is continued into looser tissue, the above-mentioned cribriform
but superiorly and inferiorly it ends in two more distinct in-
extremities, the *superior* and *inferior cornua*. The inferior

cornu, the most completely defined part of the margin, lies in the angle between the internal saphenous and the femoral veins, below their junction; while the superior cornu forms a larger curve, the inner extremity of which, often called *femoral ligament*, passing completely to the inner side of the femoral sheath, is attached to the front of Gimbernat's ligament.

It is customary to call the parts of the fascia lata which are placed external and internal to the saphenous opening the *iliac* and *pubic portions*. The iliac portion is intimately connected above with Poupart's ligament, as well as with the deep layer of the superficial fascia of the abdomen, and internally forms the falciform margin of the saphenous opening; the pubic portion, attached superiorly to the ilio-pectineal line, passes on its outer side deeply behind the sheath of the vessels, with which it is connected, and is continued into the iliac fascia to be subsequently described.

The fascia lata is perforated in many places by foramina, which allow the passage of the cutaneous nerves and blood-vessels.

The fascia lata has various deep processes. One of these, leaving the main fascia at the insertion of the tensor vaginæ femoris muscle, passes upwards on the inner side of that muscle as a strong flat band on the surface of the vastus externus, and is attached superiorly to the ilium above the origin of the posterior head of the rectus femoris, with which also it is closely connected. Two processes, the *external* and *internal intermuscular septa*, bind the fascia to the femur in the lower part of the thigh: the external septum, situated between the vastus externus and crureus in front and the short head of the biceps behind, is inserted into the linea aspera from the lower border of the tendon of the gluteus maximus to the outer condyle of the bone: the internal septum, which is much thinner, is inserted into the femur between the vastus internus and the adductor magnus, becoming blended with the tendinous attachments of those muscles.

*Sheath of the Femoral Vessels.*—The femoral vessels are surrounded by an investment of fascia, which in its upper part is particularly distinct and receives the name of the *crural sheath*. This sheath, commencing at the deep crural arch, is continuous with the transversalis fascia and iliac fascia of the cavity of the abdomen. Its outer border descends in contact with the artery, while its inner border is inclined outwards from the margin of Gimbernat's ligament, and comes in contact with the vein at the distance of less than an inch lower down: the sheath is therefore funnel-shaped. It is divided into three compartments, separated by thin septa: the outermost contains the artery, the middle one the vein, and the innermost forms a space occupied at its upper end by the crural ring, and in which there is generally a lymphatic gland and some fat. Through this passage a femoral hernia descends, and on this account it has been named the *femoral* or *crural canal*. (See later, the special account of Hernia).

## MUSCLES OF THE HIP.

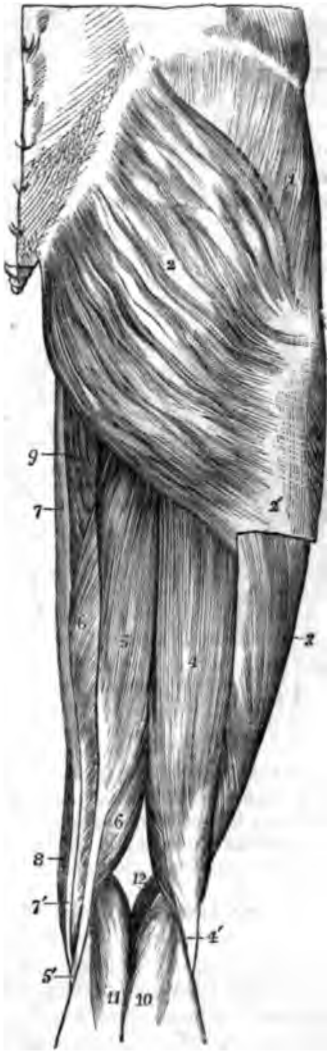
The muscles of this region are the three glutei, the tensor vaginæ femoris, the pyriformis, the obturator internus with the gemelli, the obturator externus, and the quadratus femoris.

The **gluteus maximus** is a very large and coarsely fasciculated ıdrilateral in shape, which arises from the posterior fourth of 'est, and from the rough surface of the ilium between the ıe superior curved line ; from the back of the last two pieces 'um and the first three pieces of the coccyx ; from the great

Fig. 176.

UPERFICIAL MUSCLES OF THE HIP SEEN FROM BEHIND. (A. T.) ⅕

nedius, covered by the fascia lata ; aximus ; 2′, lower part of the fas- of the gluteus maximus ; 3, vastus biceps flexor cruris ; 4′, tendon of 5, 5′, semitendinosus ; 6, 6, semi- ; 7, 7′, gracilis ; 8, sartorius ; 9, gnus ; 10, outer, and 11, inner gastrocnemius ; 12, placed in the ce, points to the origin of the



.c ligament ; and, between n and the ilium, from the s of the erector spinæ muscle. passes downwards and out- ı parallel fibres. The whole ɔer half of the muscle, and icial fibres of the lower half ɔd into the strong fascia on ıde of the thigh ; the deeper ' portion of the lower half attened tendon which is at- the gluteal ridge on the d of the shaft of the femur.

.—The lower border of the muscle 'old of the nates. The deep sur- n the gluteus medius and pyri- cles, the tendon of the obturator ith the two gemelli, the quad- ris, a small portion of the ad- gnus, the great trochanter, the erosity, and the origins of the muscles ; it covers also the sciatic . nerves as they emerge from the w the pyriformis, the superficial the gluteal artery passing out muscle, and the pudic vessels and ; behind the spine of the ischium. the fascial insertion of the l the great trochanter is a large ır bursa, or there are sometimes ee smaller ones, and another in- etween it and the upper part of externus.

ıt size of the gluteus maximus, nsequent prominence of the buttock, is a characteristic of man as com- . those animals which most nearly approach him in general structure.

r.—These are not frequent. The muscle has been seen receiving an fasciculus of origin from the lumbar aponeurosis, or joined at its lower a distinct slip from the lower part of the sacrum and coccyx, representing the agitator caudæ of the lower animals. The fibres arising from the sacro-sciatic ligament and the margin of the sacrum are normally separated by a layer of areolar tissue from the superficial portion, and a powerful development of the deep part has given rise to the bilaminar condition described by Tiedemann and others (Henle).

The **gluteus medius** muscle, covered partly by the gluteus maximus, partly by the fascia lata, arises from the surface of the ilium between the crest, the superior and the middle curved lines, and in front of the gluteus maximus from the strong fascia covering its outer surface. The muscular fibres converge as they descend, the anterior fibres passing obliquely backwards, the posterior fibres obliquely forwards, and terminate in a flattened tendon, which is inserted into an oblique impression directed downwards and forwards on the outer surface of the great trochanter. The tendon is separated by a small bursa from the upper part of the trochanter.

Fig. 177.

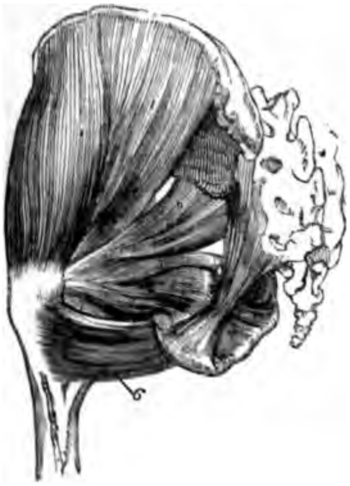


Fig. 177.—DEEP MUSCLES OF THE HIP OF THE LEFT SIDE, FROM BEHIND. ⅓

The gluteus maximus, and the muscles of the thigh have been removed. 1, 1, gluteus medius; 2, pyriformis; 3, gemellus superior; 4, gemellus inferior; 5, obturator internus, seen partially within the pelvis, and, after issuing by the small sciatic notch, between the gemelli muscles; 6, quadratus femoris; 7, tendon of the obturator externus between the gemellus inferior and quadratus.

*Relations.*—Between this muscle and the gluteus minimus are the superior gluteal nerve and the deep branches of the gluteal vessels. At its anterior border its fibres are parallel to and generally united with those of the gluteus minimus. This border also is overlapped by the tensor vaginæ femoris. The posterior border is in contact with the pyriformis, the superficial part of the gluteal vessels passing between the two.

*Varieties.*—Some of the deeper fibres of the muscle occasionally end in a separate tendon which is inserted into the upper border of the great trochanter. The posterior border of the muscle is sometimes closely united to the pyriformis, or some of the fibres end on the tendon of that muscle. A bursa is occasionally present between the tendon of this muscle and the pyriformis (1 in 15, Macalister).

The **gluteus minimus,** (fig. 178, 1) covered by the preceding muscle, arises from the whole space on the ilium between the middle and inferior curved lines. The fibres, converging as they descend, terminate in an aponeurotic tendon on the outer surface of the muscle, which becoming narrowed is inserted into an impression on the anterior border of the great trochanter. The tendon is bound down to the prominence of the trochanter by a strong fibrous band which joins it from the upper margin of the capsule of the hip-joint. A synovial bursa is interposed between the tendon and the trochanter.

*Relations.*—The anterior border of the muscle is in contact with that of the gluteus medius; its deep surface with the capsule of the hip joint, and the posterior head of the rectus femoris; its outer surface is covered by the gluteus medius, gluteal vessels and superior gluteal nerve; and its posterior border is covered by the pyriformis muscle.

*Varieties.*—This muscle may be divided into an anterior and a posterior part, or it may send detached slips to the hip joint, to the pyriformis, to the gemellus superior, or to the outer part of the origin of the vastus externus (Macalister). The anterior fibres are occasionally separate, representing the *scansorius* muscle of apes.

The **tensor vaginæ femoris** or ilio-aponeurotic muscle (fig. 180, 5) arises by tendinous fibres from the external margin of the iliac crest at its fore part, and from part of the notch between the two anterior iliac spines external to the attachment of the sartorius, and by some fleshy fibres from the fascia covering the gluteus medius: passing downwards and a little outwards and backwards it is inserted between two laminæ of the fascia lata, from three to four inches below the great trochanter of the femur. The outer of these laminæ is continued upwards on the muscle in its whole extent, being part of the general investment of the limb, the deeper is connected above with the origin of the rectus femoris, and with the fibres attaching the gluteus minimus to the hip-joint. The fibres in the fascia prolonged from the insertion of the muscle form part of the ilio-tibial band, and can be followed in this down to the outer tuberosity of the tibia.

*Relations.*—This muscle lies upon the anterior border of the gluteus medius, the upper parts of the rectus femoris and vastus externus muscles, and the ascending branches of the external circumflex artery. At its origin it lies between the sartorius and gluteus medius muscles.

The **pyriformis** muscle arises within the pelvis by three fleshy digitations from the second, third and fourth pieces of the sacrum between and outside the anterior sacral foramina, slightly from the hinder border of the ilium immediately below the posterior inferior spine, and from the great sacro-sciatic ligament. The muscle passes out of the pelvis by the great sacro-sciatic foramen, and is inserted into a mark on the upper border of the great trochanter by a rounded tendon which is closely united for some distance before its insertion to the subjacent tendon of the obturator internus and gemelli muscles.

*Relations.*—Between the upper border of the muscle as it escapes from the pelvis and the bone the gluteal vessels and the superior gluteal nerve issue; at its lower border, between it and the superior gemellus, the sciatic and pudic vessels and nerves make their appearance; its superficial surface is covered by the gluteus maximus; and its deep surface is separated by the hinder part of the gluteus minimus from the hip-joint.

*Varieties.*—This muscle is frequently pierced by a root of the great sciatic nerve or by its external popliteal branch, and is thus divided more or less completely into two parts. It may be united with the gluteus medius, or give fibres to the gluteus minimus, or receive the insertion of the superior gemellus. It may have only one or two sacral attachments, or again its tendon may be inserted into the capsule of the hip-joint. Its entire absence has also been noted.

The **obturator internus** muscle, in great part lodged within the pelvis, arises from the deep surface of the obturator membrane except at its lower part; from the fibrous arch which completes the canal for the obturator vessels and nerve; from the pelvic surface of the hip-bone, externally between the obturator foramen and the great sciatic notch, reaching up to the ilio-pectineal line, and internally between the foramen and the margin of the pubic arch; a few fibres also arise from the obturator fascia, which is in contact with the deep surface of the muscle. Its fibres converging as they proceed backwards from this origin, the muscle emerges from the pelvis by the small sacro-sciatic foramen, gliding over the trochlear surface of the ischium, and is directed outwards, to be inserted, in connection with the gemelli, into an impression on the fore part of the inner surface of the great trochanter. The tendon occupies the surface of the muscle which is towards the bone, and consists as it passes through the foramen of four or five narrow portions which, commencing independently in the substance of the pelvic portion of the muscle, receive the pinnately disposed fleshy fibres. A layer of cartilage lines the trochlear groove of the bone, and forms a series of ridges with intervening grooves corresponding to the divisions of the tendon, while the movement of the latter is facilitated by a large synovial bursa. Another bursa, of much smaller size, elongated and narrow, is sometimes placed between the tendon and the capsule of the hip-joint. These bursæ are occasionally continuous with one another.

*Relations.*—The deep surface of the pelvic portion is in contact with the obturator portion of the pelvic fascia and near its lower border with the pudic vessels and nerve. The outer surface is in contact with the bone and obturator membrane. At its upper border the obturator vessels and nerve pass through the obturator foramen. The extrapelvic portion lies between the gemelli and in contact with the ischium and capsule of the hip-joint. It is covered by the great sacro-sciatic ligament, the sciatic vessels and nerves, and by the gluteus maximus.

The **gemelli** (gemini) are two small narrow muscles, consisting chiefly of fleshy fibres extended horizontally on each side of the tendon of the obturator internus; and they are named from their position above and below the tendon. The *gemellus superior*, which is usually the smaller muscle, arises from the outer and lower part of the ischial spine; the *gemellus inferior* takes origin from the upper part of the tuberosity of the ischium, along the lower border of the groove for the obturator internus. Passing outwards, they join the tendon of the internal obturator muscle, and are inserted with that into the great trochanter. The two muscles usually meet at their origin beneath the tendon of the obturator, while at their insertion they overlap and more or less conceal it.

*Relations.*—The superior gemellus is placed immediately below the pyriformis; the inferior gemellus is above the quadratus femoris, and at its insertion is close to the tendon of the obturator externus muscle. These muscles may be regarded as portions of the obturator internus arising externally to the pelvis.

*Varieties.*—The gemellus superior is often very small, and not unfrequently is altogether absent. Absence of the gemellus inferior has also been observed, but more rarely than that of the upper muscle.

The **quadratus femoris** muscle, of an oblong shape, arises from an impression along the outer border of the ischial tuberosity, and, proceeding horizontally outwards, is inserted into the tubercle of the quadratus and the back of the femur immediately below this, reaching to the level of the small trochanter.

*Relations.*—The upper border of this muscle is in contact with the inferior gemellus; the lower with the adductor magnus, the transverse branch of the internal circumflex artery passing between the two. It conceals the outer part of

m. The fibres converge as they are directed outwards in the e between the acetabulum and the tuberosity of the ischium to the part of the hip-joint; then winding backwards and upwards, applied to the lower and hinder surfaces of the neck of the femur, nd in a tendon which is inserted into the bottom of the digital of the great trochanter.

*tions.*—The obturator externus is concealed in front by the pectineus, ilio- adductor brevis and adductor magnus muscles; near its insertion it is d behind by the quadratus femoris: its deep surface is closely connected capsule of the hip as it passes backwards. The obturator vessels are between the muscle and the obturator membrane, and the superficial part obturator nerve passes above it while the deep part perforates it near its border.

ves.—The gluteus maximus is supplied by the inferior gluteal nerve; the medius and minimus and tensor vaginæ femoris by the superior gluteal The pyriformis, gemelli, obturator internus, and quadratus femoris receive branches from the sacral plexus. The obturator externus is supplied by urator nerve.

ions.—The *gluteus maximus* muscle is the chief extensor of the hip-joint. agency the bent thigh is brought into a line with the body. The lower the muscle also acts as an adductor, and external rotator of the limb, the upper part will assist in producing abduction. Its most powerful , and that in connection with which it is so largely developed in the human , is to extend the trunk upon the thigh when bent forwards. It also into operation in ascending an incline or a stair, in leaping, and in rising he sitting posture. But although the full contraction of the glutei maximi ired to bring the body into the erect posture, it is not necessary for its nance when complete, the trunk being then supported on the thigh-bones tension of ligaments, while the body is so poised that its centre of is placed slightly behind the vertical plane passing through the middle of p-joints (see p. 170). By means of its insertion into the ilio-tibial band of cia lata, which is attached below to the fore part of the outer tuberosity tibia, the gluteus maximus is farther enabled to exercise an influence upon ee, steadying and supporting that joint in the extended position during g, when the proper extensor muscles are relaxed.

ductors when the hip is flexed. The *quadratus femoris* rotates the thigh outwards and assists in adducting. The *obturator externus* is also principally an external rotator, but it is farther a flexor and adductor of the thigh, bringing the uppermost of the two limbs into position when we cross the thighs in sitting. It supports the hip-joint posteriorly and inferiorly.

### POSTERIOR FEMORAL OR HAMSTRING MUSCLES.

At the back of the thigh are three long flexor muscles of the knee-joint; viz., the biceps, semitendinosus, and semimembranosus.

The **biceps flexor cruris** muscle consists of two parts, arising one from the hip-bone, the other from the femur, which unite inferiorly to terminate on the fibula. The *long head* arises by a tendon common to it and the semitendinosus from the inner impression on the upper part of the ischial tuberosity, receiving also some fibres from the great sacro-sciatic ligament; the *short head* arises from the outer lip of the linea aspera in its whole extent, from the upper two-thirds of the external supracondylar line, and from the adjacent external intermuscular septum. The muscular fibres from both heads end in a common tendon, which is inserted into the upper and outer part of the head of the fibula by two portions, which embrace the external lateral ligament of the knee-joint. Some of the fibres of the tendon, passing forwards and inwards, are inserted into the outer tuberosity of the tibia, and from the posterior border others are given off to the fascia of the leg.

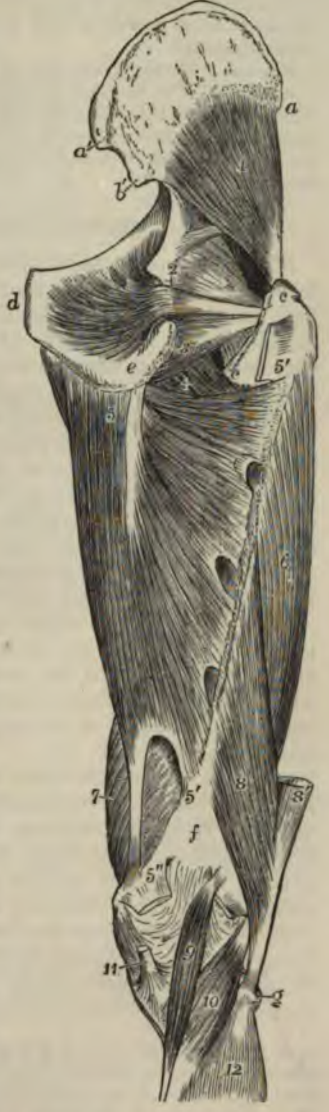
*Relations.*—The upper end of the biceps is covered by the gluteus maximus; in the rest of its extent the muscle is subcutaneous. It lies upon the semimembranosus, the great sciatic nerve, and the adductor magnus; its inner border is in contact with the semitendinosus and semimembranosus, and at its lower end it forms the upper and outer boundary of the popliteal space. A bursa is generally present between the tendon and the external lateral ligament, and there is sometimes another between the long head and the origin of the semimembranosus.

*Varieties.*—The short head may be absent, or there may be an additional head arising from the ischial tuberosity, or from the linea aspera, or from the inner supracondylar ridge of the femur, or from various other parts. A slip has been found passing from the long head to the gastrocnemius or the tendo Achillis.

The **semitendinosus** muscle, closely united at its origin with the long head of the biceps, arises from the tuberosity of the ischium, and from the tendon common to it with the biceps for about three inches; it descends on the back of the thigh, and terminates in the lower third in a long, rounded, and slender tendon, which passes along the inner side of the popliteal space, resting on the semimembranosus, and curves forwards to be inserted in an expanded form into the upper part of the inner surface of the tibia, a considerable process being sent from its lower border to the fascia of the leg. There the tendon is on the same plane with, but below that of the gracilis, both being under cover of the sartorius, and a bursa separates the three tendons from the internal lateral ligament of the knee-joint. The belly of the muscle is traversed about its middle by a thin oblique tendinous intersection.

The **semimembranosus** muscle arises from the tuberosity of the ischium, above and to the outside of the origin of the biceps and semitendinosus, by a strong flattened tendon which is grooved on its posterior surface for the adjacent origin of these two muscles. The tendon of origin is prolonged downwards on the outer side of the muscle for urths of the length of the thigh ; from it spring numerous short bres which are directed obliquely downwards and inwards, forming fusiform belly, and terminate upon the tendon of insertion on the e border of the muscle. The tendon makes its appearance he middle of the thigh, becomes m muscular fibres at the level knee, and, turning somewhat s, is inserted mainly into the art of the horizontal groove on k of the inner tuberosity of the One considerable expansion is wards and outwards to the pos- igament of the knee-joint (see , another is continued down- o the fascia covering the popliuscle, and a few fibres join the l lateral ligament of the joint.

Fig. 178.



.—DEEP MUSCLES OF THE RIGHT HIP THIGH, FROM BEHIND. (A. T.) $\frac{1}{5}$

rior, *a'*, posterior superior spine of the ', posterior inferior spine ; *c*, *c*, great l trochanters ; *d*, symphisis pubis ; *e*, berosity ; *f*, popliteal surface of femur; of fibula ; 1, gluteus minimus ; 2, obnternus : the gemelli have been re- 3, obturator externus ; 4, small part of of the pectineus and adductor brevis ; of the adductor magnus from the lower e ischial tuberosity ; 5', 5', line of in- this muscle on the shaft of the femur, are seen three arched tendinous interhe passage of the perforating vessels ; n of insertion into the adductor tu- etween the lower 5' and 5'', the interval which the femoral vessels pass into the space ; the upper 5' is placed upon the f the quadratus femoris ; 6, vastus ex- ', vastus internus ; 8, femoral head of s ; 8', its ischial head, cut short ; 9, muscle : at its upper end the outer the gastrocnemius ; the figure 5'', is cut inner head ; 10, popliteus ; 11, f the semimembranosus ; 12, upper e soleus.

*ions.*—At its upper part the seminosus crosses obliquely from without beneath the conjoined biceps and dinosus, and the latter muscle lies in its whole length. Its deep surts upon the adductor magnus, and at sciatic nerve lies along its outer

Between the lower tendon and the inner head of the gastrocnemius is a rsa which generally communicates with the cavity of the knee-joint, and l smaller one separates the main portion of the tendon from the promiper margin of the groove on the tibia.

The hamstring muscles descend for the greatest part of their length in contact with one another, being bound down by the fascia lata; but inferiorly they diverge, the biceps passing to the outside, and the semimembranosus and semitendinosus to the inner side of the knee, forming the superior borders of a diamond-shaped hollow at the back of the knee —the popliteal space—the inferior margins of which are formed by the heads of the gastrocnemius muscle.

*Varieties.*—Absence of the semimembranosus muscle has been observed. It has also been found double, or with its origin for the most part from the great sacro-sciatic ligament.

**Nerves.**—These muscles are all supplied by the great sciatic nerve.

**Actions.**—The *hamstring muscles* flex the knee, and when that joint is bent they can rotate the tibia—the biceps outwards, the semitendinosus and, to a less extent, the semimembranosus inwards. They are farther powerful extensors of the hip, and by their position they set a limit to flexion of that joint so long as the knee is extended.

### ANTERIOR MUSCLES OF THE THIGH.

The **ilio-psoas** muscle, the great flexor of the hip-joint, is divisible into two parts, a broad outer part, the iliacus, and an elongated inner part, the psoas magnus, which are sometimes described separately as two muscles. The greater part of the muscle is situated in the abdomen, only the lower conjoined portion appearing below Poupart's ligament in the thigh. Its action, however, being almost exclusively upon the hip-joint, it is most conveniently considered in this place.

The *iliacus* arises from the upper half of the iliac fossa of the hip-bone, anteriorly reaching down to the inferior spine, and posteriorly receiving a few fibres also from the ala of the sacrum and the ligament connecting the two bones. Its fibres converge as they pass downwards and inwards and are inserted for the most part into the tendon of the psoas; the outermost, however, pass directly to a special triangular surface on the upper part of the femur, in front of and below the small trochanter.

The *psoas magnus* arises by five fleshy slips from the anterior surface and lower margin of the transverse processes of the lumbar vertebræ; also from the bodies of the vertebræ by a series of thick processes, each of which takes origin from an intervertebral disc, and from the contiguous margins of two bodies, the highest being attached to the last dorsal and first lumbar vertebræ, and the lowest to the fourth and fifth lumbar vertebræ with the intervertebral substance between them. These attachments are connected by thin tendinous arches extending over the middle of each vertebra, covering the lumbar vessels and communicating branches of the sympathetic nerve, and giving origin to other muscular fibres. The various bundles of fibres speedily unite to form a thick elongated muscle, which runs along the brim of the pelvis, and emerging from the abdomen beneath Poupart's ligament is inserted into the small trochanter of the femur by means of a tendon, which is placed at first within the substance of the muscle, and afterwards at its outer side, receiving as it descends the fibres of the iliacus as well as those of the psoas.

*Relations.*—Both iliacus and psoas are covered in the abdomen by the iliac fascia, which is also prolonged downwards over the conjoined muscle into the upper part of the thigh, where it becomes continuous with the pubic portion of the fascia lata. The psoas at its upper extremity is placed behind the diaphragm, being crossed by the internal arched ligament. The external iliac artery rests against its inner border at the brim of the pelvis, but lies over the muscle as it enters the thigh. The lumbar plexus of nerves is imbedded deeply in the substance of the psoas and its branches issue from the muscle at various points. The anterior crural nerve passes into the thigh lying in the groove between the psoas and iliacus, and the ilio-inguinal and external cutaneous nerves cross the surface of the iliacus. The iliacus lies over the ilium, the anterior head of the rectus femoris, and the hip-joint, to the capsule of which a few of its fibres are sometimes attached. The psoas rests against the vertebræ, the quadratus lumborum, and the brim of the pelvis, overlapping also the inner border of the iliacus. The common tendon passes downwards in a deep groove between the anterior inferior spine and the ilio-pectineal eminence, and lower down, between the tendon and the capsule of the hip, is a large synovial bursa which sometimes communicates with the cavity of the joint.

Fig. 179.

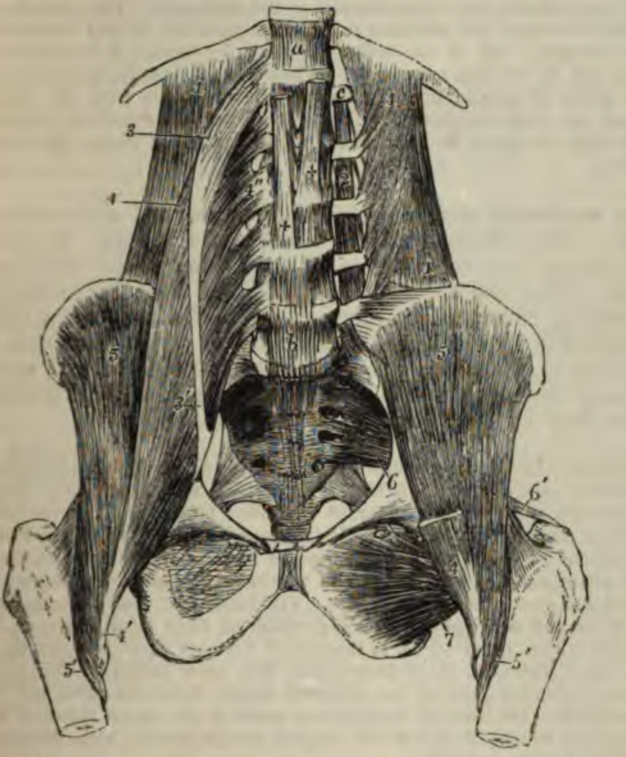


Fig. 179.—Deep muscles of the abdomen and pelvis. (A. T.) ⅓

*a*, twelfth dorsal vertebra; *b*, fifth lumbar vertebra; *c*, transverse process of the first lumbar vertebra; 1, quadratus lumborum muscle; on the left side its fibres of origin from the transverse processes of the lumbar vertebræ are shown by the removal of the psoas; 2, placed upon one of the intertransversales muscles of the left side; 3, upper part of the psoas parvus, drawn somewhat to the outer side; 3′, insertion of its tendon into the brim of the pelvis; 4, upper part of the psoas magnus; 4″, one of the origins of the muscle; 4′, insertion of the muscle into the small trochanter of the femur; 5, iliacus; 5′, insertion of the outer fibres of the iliacus below the small trochanter; 6, pyriformis muscle of the left side rising within the pelvis from the sacrum; 6′, insertion of its tendon into the summit of the great trochanter; 7, obturator externus of the left side; + +, crura of the diaphragm.

*Varieties.*—The *iliacus minor* or *ilio-capsularis* is a small detached portion of the iliacus which is frequently present. It arises from the anterior inferior spine of the ilium, and is inserted into the lower part of the anterior intertrochanteric line, or into the ilio-femoral ligament.

The *psoas parvus*, a small muscle placed on the surface of the psoas magnus, arises from the bodies of the last dorsal and first lumbar vertebræ, and from the disc between them, and soon ends in a flat tendon, which passes along the front and the inner side of the psoas magnus, being incorporated with the iliac fascia, and is inserted into the ilio-pectineal line and eminence. This muscle, although it is well developed and constant in animals generally, is very inconstant in the human subject. Out of 450 bodies examined by Gruber it was absent on both sides in 183, on one side only in 69. When present, it is liable to many changes in the place of origin; thus, it may be connected only with the first lumbar vertebra, or with the second and the intervertebral substance above it, and it has been observed to commence by two parts or heads separated by an interval.

The **sartorius** muscle is very long, narrow, and ribbon-shaped, and has the longest fibres of all the muscles of the body. It arises by a short tendon from the anterior superior spine of the ilium, and from a small part of the anterior margin of that bone immediately below, and, passing downwards and inwards across the front of the thigh, it is inserted by a thin flattened tendon into a slight roughness on the inner side of the tibia near the tubercle, sending off one aponeurotic expansion from its upper border to the capsule of the knee-joint, and another from its lower border to the fascia of the leg.

*Relations.*—In this long course the sartorius is directed obliquely inwards over the anterior part of the thigh in the upper half, and then nearly vertically on the inner aspect of the limb as far as the knee; below this it curves forwards to its place of attachment. The muscle is covered only by the fascia lata and the integument. It passes over the iliacus and rectus femoris muscles, the anterior crural nerve and femoral vessels, the pectineus, the adductor longus, adductor magnus, and vastus internus muscles. The tendon of insertion covers those of the gracilis and semitendinosus, being separated from them, however, by a prolongation of the bursa which is interposed between these tendons and the internal lateral ligament of the knee-joint. The inner border of this muscle and the most projecting part of the adductor longus form the sides, and Poupart's ligament forms the base, of a triangular space in the upper third of the thigh, through the middle of which the femoral artery passes. This usually receives the name of Scarpa's triangle.

*Varieties.*—The sartorius has in several instances been found divided into two parts similarly attached; or the accessory portion is inserted into the femur or ligament of the patella, or into the tendon of the normal one. The tendon of insertion has been found to end in the fascia lata or in the capsule of the knee-joint. A tendinous intersection has been seen in rare cases. Total absence of the muscle has also been noted.

The **quadriceps extensor cruris**, the extensor muscle of the knee, is divisible into four parts, one of which, the rectus femoris, descends from the hip-bone and is distinct to its insertion, while the other three, viz., the vastus externus, vastus internus, and crureus, are more or less closely united together, and cover the whole of the anterior and lateral surfaces of the thigh-bone, from which they arise.

*a.* The *rectus femoris* is spindle-shaped, and extends in a straight line from the pelvis to the patella. It arises from the ilium by two tendinous heads, the anterior of which is attached to the anterior inferior spine, and the posterior to the impression on the outer surface of the bone immediately above the acetabulum. The two join at a right angle close below the margin of the acetabulum, and form a tendon which is prolonged on the anterior surface, and then in the centre of the muscular mass, to beyond the middle of the thigh. From this the fleshy fibres spring pinnately, and, passing downwards and backwards as they diverge, they end on the inferior tendon which extends over the lower half of the posterior surface of the belly. The lower tendon becomes free about three inches above the patella, and forms a flat band which is attached to the upper border of that bone, being joined with the tendons of the deeper portions of the quadriceps, and forming with them the common tendon of insertion.

Fig. 180.

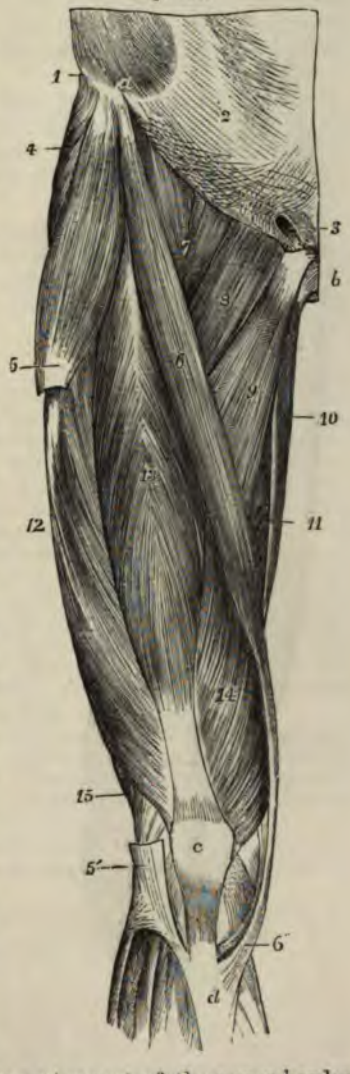


Fig. 180.—Superficial muscles of the front of the thigh. (A. T.) ⅕

*a*, anterior superior spine of the ilium; *b*, symphysis pubis; *c*, patella; *d*, tubercle of the tibia; 1, insertion of the external oblique muscle into the iliac crest; 2, its aponeurosis; 3, external abdominal ring; 4, gluteus medius; 5, tensor vaginæ femoris at the place of its insertion into the ilio-tibial band, which has been removed between 5 and 5′, where it is seen descending to be attached to the tibia; 6, sartorius; 6′, its insertion; 7, ilio-psoas; 8, pectineus; 9, adductor longus; 10, gracilis; 11, part of adductor magnus; 12, vastus externus; 13, rectus femoris; 14, vastus internus; 15, biceps flexor cruris.

*b*. The *vastus externus* has a narrow origin from the femur, along the upper half of the anterior intertrochanteric line, the fore and outer parts of the root of the great trochanter, the outer side of the gluteal ridge and the upper half of the linea aspera, and to a slight extent also from the external intermuscular septum. The origin takes place for the most part by a strong aponeurosis, which extends over the surface of the muscle for the upper two-thirds of its length. The fleshy fibres spring from this aponeurosis, and some deeper ones also from the bone immediately beneath it, and are directed downwards and forwards to end on the aponeurosis of insertion, which occupies the deep surface and anterior border of the mass in its lower half, and is continued down to the outer part of the upper border of the patella, joining the other portions in the common tendon, and sending also an expansion downwards to the capsule of the knee-joint. A few of the superficial fibres join the outer border of the rectus tendon, and its deep surface is connected to a greater or less extent with the subjacent crureus, especially in its lower part.

*c* and *d*. The remaining portions of the muscle, viz., the vastus internus and crureus, appear at first sight to be inseparably united and to form one mass. If, however, the rectus tendon be turned well downwards, there will come into view, above the patella, a narrow interval which can be followed up between the two tendons in the direction of a line from the inner part of the patella to the lower end of the anterior intertrochanteric line of the femur, and the two portions can thus be separated, although their fleshy fibres are usually continuous above. The *vastus internus*, like the vastus externus, has a narrow origin from the femur, by a superficial aponeurosis and deeper fleshy fibres, along the inner lip of the linea aspera and the line continued upwards from that, while in the lower half numerous fibres arise from the tendons of the adductor longus and adductor magnus. The muscular fibres are directed downwards and forwards, and end mostly on a deep aponeurosis which forms below the innermost part of the common tendon: the lower fibres, however, which pass inwards more obliquely than the upper ones, end by being inserted, shortly tendinous, into the inner margin of the patella for its upper half. A few superficial fibres also join the adjacent margin of the rectus tendon, and from its lower border an expansion is given off to the capsule of the knee.

Fig. 181.

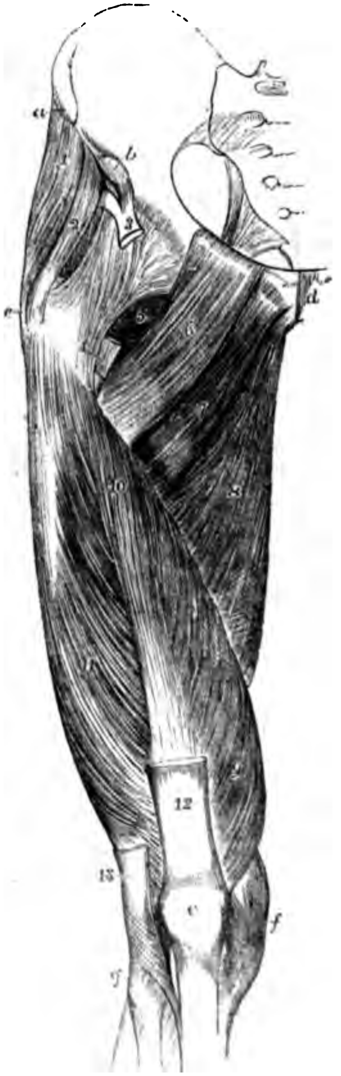


Fig. 181.—DEEP MUSCLES OF THE FRONT OF THE THIGH. (A. T.) ½

*a*, anterior superior, and *b*, anterior inferior spine of the ilium; *c*, great trochanter; *d*, symphysis pubis; *e*, patella; *f*, inner side of the knee-joint; *g*, head of the fibula; 1, gluteus medius; 2, gluteus minimus; 3, upper tendon of the rectus, dividing into its two portions; 4, points to the cut tendon of insertion of the ilio-psoas muscle; 5, part of the obturator externus and quadratus femoris; 6, pectineus; 7, part of the adductor brevis; 8, adductor magnus; 9, vastus internus; 10, crureus; 11, vastus externus; 12, lower tendon of the rectus; 13, lower part of the ilio-tibial band of the fascia lata.

The *crureus* has a fleshy origin from the anterior surface of the femur for its upper two-thirds, from the outer surface of the bone, in front of and below the attachment of the vastus externus, and from the lower half of the external intermuscular septum. The fibres are directed downwards, those of the outer and lower part also considerably forwards, and they end on a superficial aponeurotic lamina which forms the deeper portion of the common tendon. The crureus consists of four or five superposed fleshy layers, the origins of which form a series of transverse arches with intervening bare spaces on the front of the femur; and between this portion of the muscle and the vastus internus the greater part of the internal surface of the bone is also free from muscular attachment.*

The *common tendon*, in which the four portions of the quadriceps muscle terminate below, is broad and flat, and is inserted into the fore part of the upper border of the patella, a few fibres being prolonged over the anterior surface of the bone into the superficial portion of the ligamentum patellæ.

*Subcrureus*. This name is given to one or two thin bands of muscular fibres which might be regarded as the deepest layer of the crureus. It arises from the lower part of the anterior surface of the femur, and is inserted below by scattered fibres into the upper part of the synovial membrane of the knee-joint.

*Relations.*—The rectus is covered at its upper end by the tensor vaginæ femoris, iliacus and sartorius muscles, and the acetabular tendon lies beneath the gluteus minimus. In the rest of its extent it is covered only by fascia. It rests upon the capsular ligament of the hip-joint, and the deep portions of the quadriceps: behind it pass also the external circumflex artery and branches of the anterior crural nerve. The vastus externus forms the large mass on the outer side of the thigh. It is covered by the fascia lata and the aponeurotic insertions of the gluteus maximus and tensor vaginæ femoris, and its anterior border is concealed by the rectus. It rests upon the crureus, and the branches of the external circumflex artery and anterior crural nerve entering it pass between the two. The vastus internus is partly covered by the sartorius and rectus; between these muscles it is superficial, forming the prominence at the lower part of the inner side of the thigh. The crureus is almost completely covered by the rectus and vasti, only a small portion being superficial on the outer side, behind the free posterior border of the vastus externus. Beneath the common tendon is a bursa which communicates in most cases with the cavity of the knee-joint.

*Varieties.*—The parts of the quadriceps muscle are not liable to many anomalies. The rectus has been found with an additional origin from the anterior superior spine of the ilium; or, again, its acetabular origin may be wanting. The vasti muscles are sometimes bilaminar, a condition which is normal in many birds. The subcrureus frequently consist of two separate bundles.

**Nerves.**—The psoas magnus receives small branches from the lumbar plexus. The iliacus, quadriceps extensor cruris and sartorius are supplied by the anterior crural nerve.

**Actions.**—The *ilio-psoas* muscle, the flexor of the hip-joint, bends the thigh on the body, or the body on the thigh, according as either of these is the more fixed. The psoas also assists in bending the lumbar portion of the spine, either forwards or laterally.

The *sartorius* produces flexion of the hip and knee-joints, accompanied by eversion of the thigh: it also assists in rotating inwards the leg. It has been supposed to be the muscle principally concerned in producing the posture assumed by the tailor in sitting, and hence its name; but Duchenne denies that this is its special action.

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* A detailed and accurate description of the anatomy of the quadriceps extensor muscle is given by W. R. Williams, Journ. Anat. xiii. 204.

The *quadriceps extensor cruris* extends the knee-joint; but its action is not required for the maintenance of the erect attitude (see p. 176), the knee-joint remaining in complete extension without muscular aid while the foot is firmly planted on the ground. This may be tested by the fact that the patella of a person standing with the knee extended will be found to lie quite loosely, but will become at once fixed when an attempt is made to lift the foot. The *rectus* muscle, besides extending the knee, also flexes the hip: it acts mainly from its anterior head of origin when the thigh is fully extended, and the posterior head becomes tense when the thigh is bent.

### INTERNAL FEMORAL OR ADDUCTOR MUSCLES.

The **gracilis** or **adductor gracilis** muscle, long and slender, arises by an aponeurotic tendon from the inner margin of the pubic bone, along the lower half of the symphysis and the upper half of the pubic arch. Thin and flat at first, the muscle becomes narrower and thicker as it descends; and in the lower third of the thigh it ends in a rounded tendon which curves forwards below the knee, and, becoming flattened and expanded, is inserted into the inner side of the tibia, on the same plane with but higher than the semitendinosus, and under cover of the tendon of the sartorius.

*Relations.*—This muscle is covered by the fascia lata, except where its tendon is overlapped by the sartorius; the deep surface rests against the adductor brevis and adductor magnus, and the tendon crosses the internal lateral ligament of the knee-joint. A bursa separates it from that ligament.

The **pectineus** muscle, flat and oblong, arises from the ilio-pectineal line, and slightly from the surface of bone in front of it, between the ilio-pectineal eminence and the pubic spine; a few superficial fibres spring also from the upper part of the fascia covering the muscle. Inclining outwards and backwards as it descends, it is inserted by a flat tendon into the femur behind the small trochanter, and into the upper part of the line which connects the linea aspera with that prominence.

*Relations.*—The pectineus is in relation, by its anterior surface, with the pubic portion of the fascia lata and the femoral vessels; by the posterior surface, with the obturator nerve, and the external obturator and adductor brevis muscles. Its outer border is in contact with the psoas magnus, and the internal circumflex vessels pass between the two; its inner border touches the adductor longus.

The **adductor longus,** a flat triangular muscle, internal to the pectineus, and lying in the same plane, arises by a short tendon from the body of the pubis below the crest and near the angle, and is inserted into the inner margin of the linea aspera, by an aponeurotic tendon which is closely united to the vastus internus in front and the adductor magnus behind.

*Relations.*—This muscle is covered by the fascia lata, the sartorius, and the femoral vessels; the posterior surface rests on the adductor brevis and adductor magnus, the deep femoral artery and the superficial portion of the obturator nerve. The outer border touches the pectineus above, but is separated from it by a small interval below; the inner border is in apposition with the gracilis and forms the inner boundary of Scarpa's triangle.

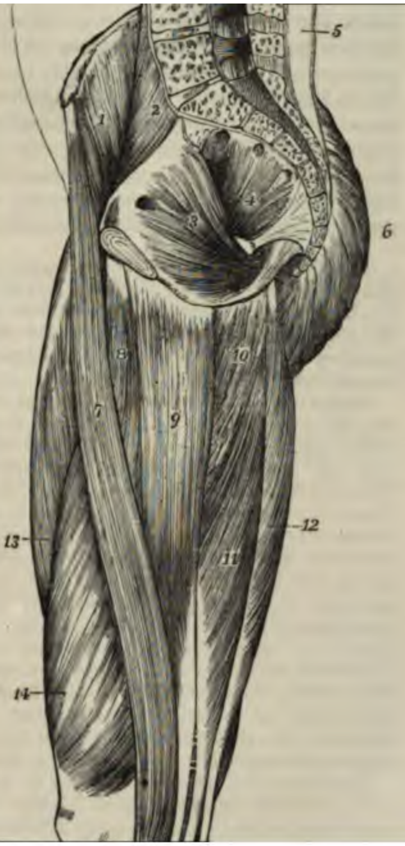
The **adductor brevis,** thick above and broad below, has a fleshy and tendinous origin, from the femoral surface of the body and inferior

ternus, with its fibres converging
the small sacro-sciatic foramen ;
formis, with three heads of origin,
fibres converging towards the
acro-sciatic foramen ; 5, lumbar
osis covering the erector spinæ
; 6, gluteus maximus ; 7, sarto-
, its tendon inserted below the
ity of the tibia ; 8, adductor
9, gracilis, 9′, its tendon passing
hat of the sartorius ; 10, part of
uctor magnus ; 11, semimembra-
12, semitendinosus, 12′, its in-
and between 9′ and 12′, the
of the semimembranosus passing
sertion on the inner tuberosity of
a.

trochanter of the femur to
ea aspera, immediately be-
e insertion of the pectineus.

*tions.*—The adductor brevis is
ed at its origin by the ad-
longus and at its insertion in
the pectineus ; it is crossed
superficial division of the ob-
nerve, and by the deep femoral
it rests on the adductor mag-
d deep division of the obtu-
erve, and by its deep surface
ntact superiorly with the ob-
externus, the internal circum-
ery passing between.

**adductor magnus** muscle
8) arises slightly from the



internal to the gluteal ridge, into the whole length of the linea aspera, and into the internal supracondylar line for about an inch. The posterior fibres, which arise from the ischial tuberosity, descend almost vertically, forming the thick inner border of the muscle, and terminate in a rounded tendon, which is inserted into the adductor tubercle on the inner condyle of the femur.

Along the femoral attachment the insertion is interrupted by three or more tendinous arches through which pass the perforating arteries, and below the level of the inferior bifurcation of the linea aspera, between the two portions of the insertion of the muscle, an interval is left for the passage of the femoral vessels backwards into the popliteal space. Extending upwards from the opening for the femoral vessels, is an aponeurotic membrane which consists of transverse fibres passing from the surface of the vastus internus to the adductor magnus and adductor longus muscles. It becomes thinner as it ascends, and encloses a three-sided passage called *Hunter's canal*, which contains the femoral artery and vein, together with the internal saphenous nerve.

*Relations.*—This muscle is in contact in front with the long and short adductors, the vastus internus, the obturator nerve, and the profunda artery, behind with the hamstring muscles, gluteus maximus, and great sciatic nerve, internally with the gracilis muscle, superiorly with the obturator externus and quadratus femoris muscles, and along the line of attachment to the femur it is pierced by the femoral and perforating arteries.

**Varieties.**—The adductor muscles are so closely related that their varieties may be conveniently considered together. The *pectineus* is sometimes divided more or less completely into two parts, which receive their nerves from different sources, viz., the inner from the obturator, and the outer from the anterior crural. This division occurs naturally in many animals. The muscle has also been seen attached to the capsule of the hip-joint, or even inserted into it. The *adductor longus* may be double, or it may extend as far as the knee with its tendon of insertion inseparable from that of the adductor magnus. Its outer border may be continuous with, or receive a slip from, the adjacent edge of the pectineus. The *adductor brevis* is frequently found divided into two or three parts, or it may be incorporated with the adductor magnus. The *adductor magnus* varies in the degree of its segmentation. Its condylar part has been found quite distinct from the rest of the muscle. Its upper part, reaching down to about the middle of the linea aspera, is so frequently divided from the rest that it is looked upon by some anatomists as a special muscle, being called the *adductor minimus* (Henle, Günther, Macalister). On the other hand, the muscle has been found with its upper part completely united to the quadratus femoris (Macalister).

**Nerves.**—The adductor muscles as a whole are supplied by the obturator nerve, but the adductor magnus likewise receives a branch from the great sciatic, and the pectineus has regularly a branch from the anterior crural, whilst its offset from the obturator nerve is inconstant.

**Actions.**—All of these muscles adduct the thigh. In addition to this action, the *pectineus, adductor longus* and *adductor brevis* are accessory flexors of the hip, while the strong part of the *adductor magnus* springing from the ischial tuberosity aids in extending that joint. The *gracilis* also flexes the knee and rotates the leg inwards. The adductors, acting with their opponents the gluteal muscles, balance the body upon the femur in walking, and the adductor magnus supports the pelvis and steadies the hip-joint in standing.

## MUSCLES AND FASCIÆ OF THE LEG.

FASCIÆ.—The **aponeurosis of the leg** invests the muscles closely, but is not continued over the subcutaneous surfaces of the bones. It is thus intimately united with the periosteum over the head and the anterior and inner borders of the tibia, the head of the fibula, and the inner and outer malleoli. It is thicker on the front of the leg than behind, especially at the upper part, where it is very dense and gives origin to the subjacent muscles. Posteriorly it is continuous with the fascia lata on the back of the thigh, and near the knee it receives accessions from the tendons of the biceps externally, and the sartorius, gracilis, and semitendinosus internally. Over the popliteal space it consists of strong transverse fibres, which bind together the muscles of the outer and inner sides, and it is perforated at the lower part of the space by the external saphenous vein; lower down it becomes much thinner over the gastrocnemius muscle. From the deep surface of the fascia intermuscular septa are sent inwards, and give origin to the adjacent muscles: on the outer side two of these pass inwards to be attached to the anterior and external borders of the fibula, and thus separate the peroneal muscles from those of the front and back of the leg respectively; and in front there is one septum, confined to the upper third of the leg, between the tibialis anticus and extensor longus digitorum muscles.

Beneath the gastrocnemius and soleus muscles on the back of the leg, a deep layer of fascia is stretched from side to side, binding down the deeper muscles firmly in the hollow between the tibia and fibula. Where it is covered by the soleus and gastrocnemius, this fascia is weak, but it becomes stronger as it escapes from under cover of those muscles and approaches the malleoli.

Below the ankle the deep fascia of the leg becomes continuous with that of the foot. In front, and on the sides of that joint, it is strengthened by broad bands of fibres, which are called annular ligaments, and serve to confine the tendons in their positions.

**The anterior annular ligament** includes two structures, one placed at the lower part of the leg, the other opposite the bend of the ankle. The *upper band*, of considerable breadth, stretches transversely from the anterior border of the fibula to the corresponding part of the tibia, and binds down the vertical portion of the extensor tendons as they descend to the foot: the tendon of the tibialis anticus alone has a synovial sheath under this part of the ligament. The *lower band* presents superficially the appearance of the letter ⤙ placed thus upon its side, being single in its outer half, and divided into two branches internally. The outer portion springs from the fore part of the os calcis, immediately in front of the interosseous ligament, and forms a strong loop which completely surrounds the peroneus tertius and extensor longus digitorum muscles. From the extremity of the loop the fibres are continued into the two branches, which are, however, less regular in their arrangement: the strongest and most constant band passes to the internal malleolus, crossing over the extensor hallucis, and on the deep surface of the tibialis anticus tendon, only a few fibres passing superficially to the latter; while the lower band, after crossing both those tendons, is inserted on the inner side of the foot into the fascia of the sole. The tendons are surrounded by three synovial sheaths under this part of the ligament: one is common to the peroneus tertius and extensor longus digitorum; the second invests the extensor proprius hallucis; and the third, on the tibialis anticus, is continuous with that under the upper band of the ligament.

**The internal annular ligament** crosses the space between the inner ankle and the heel, through which the tendons of the flexor muscles run. Its upper border, continuous with the fascia of the leg (more especially the intermuscular layer), is very imperfectly defined; and its lower border, giving origin to many fibres of the abductor hallucis, is but little more distinct. Its anterior extremity is attached to the inner malleolus, and its posterior to the inner side of the calcaneum ; but between these two points it arches over several osseous grooves so as to form canals for the passage of tendons. The first canal (next to the malleolus) contains the tendon of the tibialis posticus, and the second that of the flexor longus digitorum, each being provided with a synovial lining. Then follows a wider space for the passage of the posterior tibial vessels and nerve. Lastly a fourth canal upon the astragalus, lined like the first two by a synovial bursa, transmits the tendon of the flexor longus hallucis.

The **external annular ligament** extends from the point of the outer malleolus to the outer side of the calcaneum, and keeps in place the tendons of the long and short peroneal muscles. The tendons are close together, and are surrounded by one synovial sac.

MUSCLES.—The muscles of this part are divided naturally into three groups, which occupy respectively the front, the outer side, and the back of the leg.

## ANTERIOR REGION.

Between the tibia and fibula, and on the front of the leg, are placed four muscles—the tibialis anticus, extensor proprius hallucis, extensor longus digitorum, and peroneus tertius.

The **tibialis anticus** arises from the lower part of the external tuberosity of the tibia, and from the upper half of the outer surface of that bone ; from the adjoining portion of the interosseous membrane ; from the strong fascia of the leg ; and from the intermuscular septum between it and the extensor longus digitorum. The tendon glides in a synovial sheath beneath the anterior annular ligament, and is inserted into a rounded mark on the inner and lower part of the internal cuneiform and into the contiguous extremity of the first metatarsal bone, dividing slightly into two slips as it descends.

*Relations.*—This muscle lies immediately under the aponeurosis of the leg. It rests upon the tibia, and the interosseous membrane. Its outer surface is in contact with the extensor longus digitorum, the extensor proprius hallucis, and the anterior tibial vessels and nerve. Its tendon passes over the lower end of the tibia, the ankle-joint, and the inner surface of the tarsus. A small bursa is frequently placed under it close to its insertion.

*Variations.*—In cases of talipes the tendon of this muscle has been found split into two, one half going to the usual place of insertion, the other to the astragalus or first metatarsal bone : the whole tendon has also been seen inserted into the plantar fascia. The *tibio-fascialis anticus* is a small muscle described by Wood, arising from the lower third of the anterior edge of the tibia over the tibialis anticus, and inserted into the annular ligament and deep fascia. It may also exist as a tendinous slip from the tibialis anticus.

The **extensor proprius hallucis** muscle (extensor proprius pollicis pedis), placed between the tibialis anticus and the extensor longus digitorum, arises from the middle two-fourths of the narrow anterior surface of the fibula, and from the contiguous portion of the interosseous membrane. Its tendon passes through a distinct compartment in the lower portion of the annular ligament and along the dorsum of the foot, to be inserted into the base of the terminal phalanx of the great toe. An expansion given off from the tendon on each side spreads over the joint between the metatarsal bone and the first phalanx.

Fig. 183.

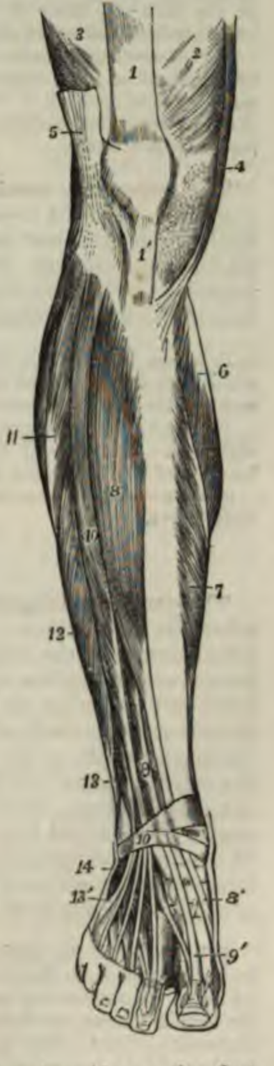


Fig. 183.—MUSCLES OF THE LEG AND FOOT FROM BEFORE. (A. T.) ⅓

1, tendon of the rectus femoris; 1′, ligamentum patellæ; 2, vastus internus; 3, vastus externus; 4, sartorius; 5, ilio-tibial band of the fascia lata; 6, inner head of the gastrocnemius; 7, inner part of the soleus; 8, tibialis anticus; 8′, its tendon near its insertion; 9, extensor proprius hallucis; 9′, its tendon; 10, extensor longus digitorum; 10′, lower band of the anterior annular ligament; 11, peroneus longus; 12, peroneus brevis; 13, peroneus tertius; 13′, its tendon at its insertion; 14, origin of the extensor brevis digitorum, the first head of which is seen passing to the great toe near the line from 9′.

*Relations.*—This muscle is partly concealed by those between which it is placed. It lies external to the anterior tibial artery at its origin, but crosses in front of that vessel in the lower third of the leg, and is internal to it on the foot.

*Varieties.*—The *extensor ossis metatarsi hallucis* is a small muscle, sometimes found as a slip from the extensor proprius, or from the tibialis anticus, or from the extensor communis digitorum; or it may be a distinct muscle arising close to the extensor proprius, and traversing the same compartment of the annular ligament with that muscle.

The *extensor primi internodii hallucis*, another occasional muscle, is nearly always an offshoot from the extensor proprius, though it has been found separate. It was seen by Wood in one half of the subjects examined by him.

The **extensor longus digitorum pedis** arises from the external tuberosity of the tibia; from the head and the anterior surface of the fibula for about three-fourths of its length, in front of the extensor hallucis; from a small part of the interosseous membrane at its upper part; also from the aponeurotic septa intervening between it and the muscles on each side, and from the fascia of the leg. The muscle ends in four tendons, which descend through the lower part of the annular ligament, in the same sheath as the peroneus tertius, and on the dorsum of the foot pass respectively to the four outer toes. The three inner tendons are each joined at the outer side, on the first phalanx, by a tendon from the extensor brevis digitorum. All the four tendons are continued into expansions, which are joined on the first phalanx by tendinous processes from the lumbricales and interosseous muscles; they divide into three parts, their middle fibres being inserted [illegible] while their lateral parts unite together and are [illegible] in a manner exactly similar to the arrangement [illegible] tendons of the fingers (p. 220).

[illegible] contact internally with the tibialis anticus and extensor [illegible] externally with the peronei muscles. It rests upon the [illegible] the tibia, the anterior surface of the fibula, the lower end [illegible] of the ankle-joint, and the extensor brevis digitorum. [illegible] nerve passes obliquely beneath its upper part.

[illegible] muscle varies considerably in the mode of origin and the [illegible] various tendons. The tendons to the second and fifth toes [illegible] doubled, or extra slips are given off from one or more tendons to [illegible] metatarsal bones, or to the short extensor, or to one of the [illegible]

[illegible] **peroneus tertius** muscle arises below the extensor longus [illegible] the lower fourth or more of the anterior surface of the [illegible] lower part of the interosseous membrane, and from the [illegible] septum which separates it on the outer side from the [illegible] Its tendon is inserted into the upper surface of the [illegible] metatarsal bone.

[illegible] It is placed to the outer side of the long extensor of the toes, with [illegible] usually united at its origin, and it passes through the same compartment [illegible] annular ligament with that muscle.

[illegible] The peroneus tertius is sometimes as large as the extensor longus [illegible] frequently terminates partly or wholly on the fourth metatarsal [illegible] sometimes altogether wanting.

[illegible] All the muscles of the front of the leg are supplied by the anterior [illegible]

## EXTERNAL REGION.

[illegible] **peroneus longus** muscle arises by a few fibres from the outer [illegible] the tibia; from the head and upper two-thirds of the external surface of the fibula; from the fascia of the leg; and from the [illegible] septum on each side. The muscular fibres end in the [illegible] the leg on a tendon which passes downwards with that of [illegible] brevis in the hollow behind the external malleolus; it next [illegible] forwards on the outer side of the os calcis, and then winds round [illegible] border of the foot to enter the groove on the lower surface of [illegible] bone; finally, crossing the sole obliquely inwards and forwards, [illegible] inserted into an impression on the lower and posterior part [illegible] metatarsal bone, and slightly into the adjoining part of the [illegible] cuneiform bone: an offset is frequently sent from it to the base [illegible] second metatarsal bone.

[illegible] At its origin the peroneus longus lies between the extensor [illegible] communis in front and the soleus and flexor longus hallucis behind: in [illegible] part of the leg it lies behind the peroneus brevis. Its attachment to [illegible] interrupted for about an inch below the head of the fibula, where the [illegible] popliteal nerve passes beneath it. Behind the external malleolus the [illegible] both peronei are contained in the same sheath under the annular ligament; on the outer side of the os calcis each tendon has its own sheath, the [illegible] separated by a fibrous septum and by the peroneal spine of the calcaneum when that process exists. A single synovial sac invests both tendons [illegible] two processes downwards into the special sheaths. In the sole of the [illegible] tendon of the peroneus longus lies in a fibrous sheath formed by the long plantar ligament, and is surrounded by a second synovial membrane. A sesamoid fibro-cartilage, or sometimes a bone, is found in that part of the tendon which plays over the ridge of the cuboid.

The **peroneus brevis** arises from the lower two-thirds of the external surface of the fibula, extending upwards in front of the peroneus longus, and from the intermuscular septum on each side. Its tendon passes down behind the external malleolus, and then inclines forwards to be inserted into the projection at the base of the fifth metatarsal bone, sending in most cases a small slip to join the extensor tendon of the little toe, or to the fore part of the metatarsal bone.

*Relations.*—In front it is in contact with the extensor longus digitorum and the peroneus tertius, and behind with the peroneus longus and flexor longus hallucis. The common synovial membrane surrounds the tendon under the annular ligament, and sends a prolongation into its special sheath, above that for the peroneus longus.

*Varieties.*—The *peroneus accessorius* arises from the fibula between the peroneus longus and brevis, and joins the tendon of the former in the sole of the foot. The *peroneus quinti digiti* arises from the lower fourth of the fibula under the peroneus brevis, and is inserted into the extensor aponeurosis of the little toe; this is of rare occurrence as a distinct muscle, but it appears to be represented normally by the above-mentioned slip of the tendon of the peroneus brevis. *Peroneus quartus* (Otto) arises from the back of the fibula, between the peroneus brevis and the flexor hallucis, and is inserted into the peroneal spine of the os calcis or into the ridge of the cuboid.

**Nerves.**—The peroneus longus and brevis are supplied by the musculo-cutaneous branch of the external popliteal nerve.

### POSTERIOR REGION.

The muscles at the back of the leg consist of a superficial group inserted into the extremity of the calcaneum, and a deeper group covered in by a deep fascia and for the most part descending to the sole.

The SUPERFICIAL GROUP consists of three muscles; two of them, the gastrocnemius and soleus, are of large size, form the bulk of the calf of the leg, and descend, the one lying on the surface of the other, to be inserted by a common tendon—the tendo Achillis; the third, a small muscle, the plantaris, passes downwards between the other two.

The **gastrocnemius** muscle consists of two large heads which arise from the lower end of the femur, and terminate about the middle of the leg in a common tendon. The outer head takes origin from a depression on the outer side of the external condyle, above the tuberosity, and from the hinder surface of the femur immediately above the condyle. The inner head arises from an impression on the upper part of the internal condyle, close behind the adductor tubercle, from the lower end of the internal supracondylar ridge, and from an adjoining roughened part of the popliteal surface of the femur. The lateral part of each origin takes place by means of a strong tendon which is attached to the impression on the condyle, and spreads out as it descends on the surface of the head, while the central part consists of short tendinous fibres, which are succeeded by a prominent fleshy mass extending along the part of the head next to the middle line of the limb. The two heads enlarge downwards as fresh fibres are added from the superficial tendons, and their adjacent borders converge and soon meet, but do not join, being separated superficially by a longitudinal groove, and deeply by a thin tendinous band which is seen when the fleshy fibres are drawn aside.

The short muscular fibres incline forwards, and end obliquely on the surface of the inferior tendon, which is broad and aponeurotic as it occupies the deep surface of the muscle, but becomes narrower and thicker as it proceeds downwards to be united with the subjacent tendon of the soleus in the tendo Achillis.

Fig. 184.

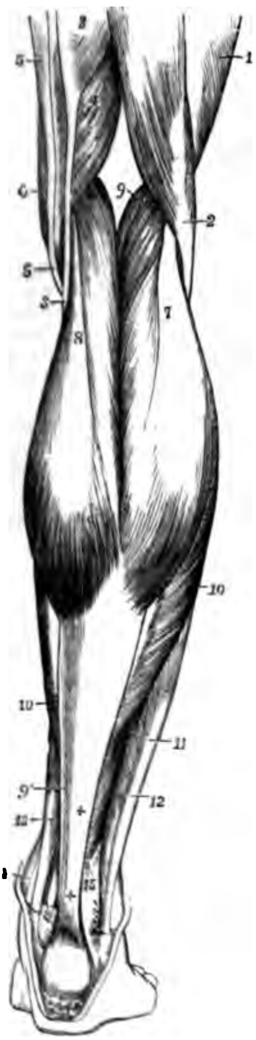


Fig. 184.—Superficial muscles of the leg, seen from behind (after Bourgery). ½

1, lower part of the vastus externus; 2, biceps femoris cruris; 3, semitendinosus; 4, semimembranosus; 5, gracilis; 6, sartorius; 7, outer, and 8, inner head of the gastrocnemius; 9, placed in the popliteal space, points to the plantaris; 9′, its thin tendon on the inner side of the tendo Achillis; 10, 10, fibres of the soleus descending to the flat tendon which, joining with that of the gastrocnemius, forms, + +, the tendo Achillis; 11, peroneus longus; 12, peroneus brevis; 13, flexor longus digitorum; 14, tibialis posticus; 15, is placed on the lower part of the fibula, and points to the lower fibres of the flexor longus hallucis, the tendon of which is seen descending over the tibia at 15′.

The lower edge of each muscular part presents a convexity downwards; and the inner head, besides being broader and thicker, also descends lower than the outer. A synovial bursa, usually communicating with the knee-joint, lies beneath the inner head of origin, and separates it from the tendon of the semimembranosus muscle. In the outer head a sesamoid fibro-cartilage is sometimes met with over the outer condyle of the femur, and it is occasionally found ossified.

*Relations.*—The heads of the gastrocnemius muscle form the inferior boundaries of the popliteal space, and are placed between the hamstring muscles: the peroneal nerve is lodged between the external head and the biceps. The gastrocnemius conceals the popliteus, plantaris and soleus muscles, with the popliteal vessels and internal popliteal nerve. The short saphenous vein is placed over, and the tibial communicating nerve descends in, the interval between its two heads.

*Varieties.*—The gastrocnemius is not unfrequently joined by a bundle of muscular fibres which arises separately from some part of the popliteal surface of the femur. This bundle has been seen passing between the popliteal artery and vein. Absence of the outer head or even of the whole muscle has also been observed.

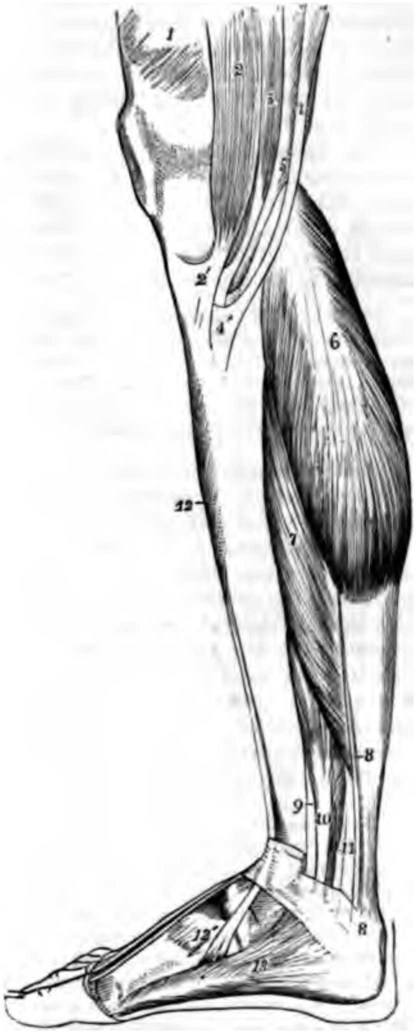
The **soleus** muscle arises externally from the posterior surface of the head and upper third of the shaft of the fibula; internally from the oblique line and the posterior border of the tibia, as far down as the middle of the bone; and between the tibia and fibula, from a tendinous band which arches over the popliteal vessels and nerve. The muscular fibres spring in part from the bones, but to a much

tent from two tendinous laminæ which descend, the outer from
, and the inner from the arch over the vessels and the oblique
; tibia, in the substance of the muscle, on the front surface of

Fig. 185.

SUPERFICIAL MUSCLES OF
SEEN FROM THE INNER
r Bourgery). ¼

internus ; 2, sartorius ;
n, spreading on the inner
of the tibia ; 3, gracilis ;
inosus ; 4′, its insertion ;
n 2′ and 4′, that of the
, semimembranosus ; 6,
f the gastrocnemius ; 7,
7′, placed upon the tendo
int to the tendon of the
scending on the inner
all part of the tendon of
osticus ; 10, flexor longus
11, flexor longus hallucis ;
anticus ; 12′, its tendon
; 13, abductor hallucis.



ch appears by one
opposite edge being
obliquely towards the
ne of the leg. The
m the anterior sur-
these laminæ con-
a median tendinous
rhich also appears on
t of the muscle by
r, while those arising
ir posterior surfaces
ted downwards and
s, and end in an
sis which covers the
art of the posterior
f the mass, and over
e tendinous surface
astrocnemius glides.
don of insertion is
l downwards from
eurosis, being joined
r by the median sep-
l forms the deeper
er part of the tendo
The fibres of the
e numerous and short,
, length of at most from two to three inches, and they are
l downwards on the deep surface of the tendo Achillis to within
istance of the heel.

s.—The soleus rests upon the flexor longus hallucis, flexor longus digi-
d tibialis posticus muscles, together with the posterior tibial vessels
, from which, however, it is separated by the deep aponeurosis.

s.—To the soleus an accessory portion is occasionally added at its [illegible] on the inner side of [illegible] the os calcis, or to the [illegible]

[illegible] thickest and strongest [illegible] flat tendons of the [illegible] commencement near the [illegible] downwards and becomes [illegible] it then expands [illegible] posterior surface of the [illegible] interposed between the upper part [illegible]

[illegible] arises from the femur [illegible] the posterior ligament of the [illegible] four inches in length [illegible] inclines inwards between the [illegible] along the inner border of the [illegible] into the posterior part of the [illegible]

[illegible] varies in its mode of termination [illegible] ends in the deep fascia of the leg [illegible] is sometimes enclosed in the lower part [illegible] absent altogether. This muscle [illegible] in man, is of large size in some [illegible] to the plantar fascia and the short flexor of the [illegible]

[illegible] posterior muscles of the leg is [illegible] consists of the popliteus, flexor longus [illegible] and tibialis posticus.

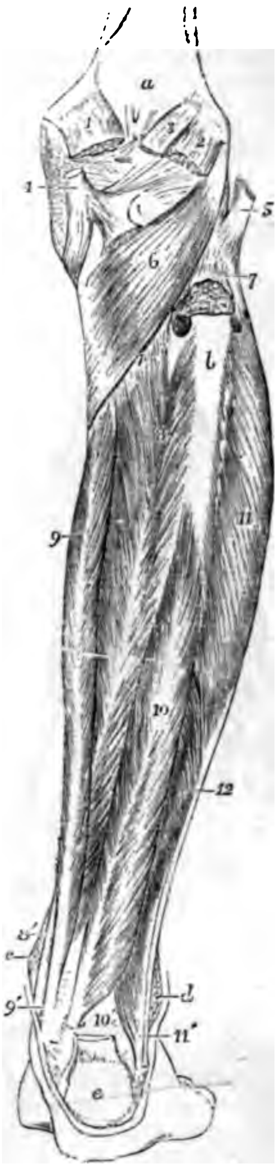
**[illegible]opliteus,** [illegible] muscle placed below the knee, arises [illegible] an inch in length, from the lower part [illegible] of the external condyle of the [illegible] ligament and capsule of the knee-joint [illegible] semilunar fibro-cartilage, and receives [illegible] posterior ligament of the joint. The [illegible] downwards and inwards, and are inserted [illegible] of the tibia above the oblique line, and [illegible] the muscle. Its tendon occupies the groove [illegible] knee-joint is fully flexed.

[illegible] is bound down by an aponeurosis [illegible] semimembranosus muscle. The plantaris and gastro- [illegible] vessels and internal popliteal nerve lie upon its [illegible] synovial membrane of the knee-joint sends a [illegible] tendon and the back of the outer tuberosity of the tibia. [illegible] has been seen with an additional head of origin from [illegible] the outer head of the gastrocnemius. The [illegible] of rare occurrence, arising from the femur on the inner [illegible] inserted into the posterior ligament of the knee-joint. [illegible] muscle described by W. Gruber, and found by him [illegible] in a large number of subjects. It arises from the [illegible] fibula, and is inserted into the upper end of the [illegible] situated beneath the popliteus. It is constant in [illegible] p. [illegible], and 187[illegible], p. 454.)

[illegible] muscles of this group are bound down together [illegible] extends between the tibia and fibula, and sepa- [illegible]

**exor longus digitorum pedis** muscle, or **flexor perforans,**
m the inner portion of the posterior surface of the tibia (see
**its** attachment extending over the
;wo-fourths of the length of the
; likewise receives fibres from a
neurosis which covers the tibialis
and is attached to the inner border
ibula, and from which the flexor
allucis also takes origin. Its ten-
ends in a groove behind the in-
alleolus, lying outside that of the
osticus, and invested by a distinct
and synovial sheath; it is then
obliquely forwards and outwards
: sole of the foot, crossing be-
tendon of the flexor longus
inferiorly, to which it is con-
y a tendinous slip; it there divides
r parts, which pass forwards to
ted into the terminal phalanges
four smaller toes. Each digital
nters a fibrous sheath on the toe
i it belongs, perforates the corre-
; tendon of the flexor brevis
m, and is invested with synovial
ne and connected by vinculum ac-
to the phalanges; the whole arrangement being essentially the
that which has been already described in the fingers (see p. 217).

Fig. 186.



–Deep posterior muscles of the leg. (A. T.) ¼

eal surface of the femur; *b*, bare surface per third of the fibula; from which the cle has been removed; *c*, internal malleo- ternal malleolus; *e*, tuberosity of the os i a part of the tendo Achillis inserted into e plantaris on its inner side; 1, inner he gastrocnemius, cut short; 2, outer plantaris; 4, tendon of the semimem- nuscle near its insertion, seen spreading rtions, viz., to the tibia, to the popliteal to the posterior ligament; 5, tendon of inserted into the head of the fibula; 6, nuscle; 7, upper part of the origin of the n the fibula, cut short; 7', line of its n; between these figures is seen the per- the upper part of the interosseous mem- tibialis posticus; 8', its tendon, passing e flexor longus digitorum and the tibia; ngus digitorum; 9', its tendon, with that alis posticus, passing behind the internal 10, flexor longus hallucis; 10', placed tendon, where it passes over the tibia galus; 11, peroneus longus; 11', its hind that of the peroneus brevis, passing nd the external malleolus; 12, peroneus

*Relations.*—It rests upon the tibia and upon the tibialis posticus muscle, crossing the latter obliquely in the lower third of the leg. It is covered at the upper part by the soleus and inferiorly by the aponeurosis of the leg. Upon it also lie the posterior tibial vessels and nerve.

*Varieties.*—A supplementary head, *flexor accessorius longus digitorum*, is not unfrequently found rising from the fibula, or the tibia, or the deep fascia, and ending in a tendon which, after passing beneath the internal annular ligament, joins the tendon of the long flexor, or the accessorius. It has also been seen replacing the latter muscle. It rarely sends a slip to the flexor hallucis tendon. Gies describes an accessory slip from the tibialis anticus, which joined the flexor digitorum at the ankle. A *flexor proprius digiti secundi* was found by Bahnsen, arising from the back of the tibia.

Intimately connected with the tendon of the flexor longus digitorum are the flexor accessorius and the lumbricales muscles, which, although they are situated in the foot, may be most conveniently described in this place.

Fig. 187.

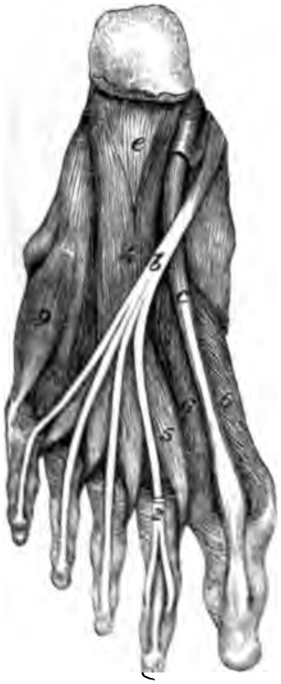


Fig. 187.—SECOND LAYER OF MUSCLES OF THE SOLE.

*b*, tendon of flexor longus digitorum; *c*, tendon of flexor longus hallucis; *e*, long plantar ligament; 1, tendon of flexor brevis digitorum to second toe, cut short; 4, flexor accessorius; 5, first lumbricalis; 6, 6, flexor brevis hallucis; 9, flexor brevis minimi digiti; 10, third plantar interosseous muscle.

The **flexor accessorius** arises by two heads, the internal and larger of which is fleshy, and is attached to the inner surface of the calcaneum, while the external, flat, narrow, and tendinous, is attached to the outer surface of the calcaneum a little in front of the external tubercle, and to the long plantar ligament. These origins unite to form a muscular mass which is inserted into the external border and upper surface of the tendon of the flexor longus digitorum.

*Variations.*—The outer head of the muscle is often absent. The number of digital tendons to which the fibres of the accessorius can be followed is subject to considerable variation. Most frequently offsets are sent to the second third and fourth toes: in many cases however to the fifth as well: occasionally to two toes only. More rarely a slip joins the tendon of the flexor hallucis, and the muscle has been seen to end entirely on that tendon (G. D. T).

The **lumbricales** muscles, four in number, arise from the tendons of the flexor longus digitorum at their point of division, each being, with the exception of the most internal, attached to two tendons. They pass forwards to the inner sides of the four outer toes, each muscle ending in a tendon, which is inserted into the expansion of the extensor tendon on the dorsum of the first phalanx of the toe.

[1] *Variations.*—Absence of one or more of the lumbricales has been observed; also doubling of the third and fourth. The insertion of these muscles frequently takes place, partly or wholly, into the first phalanges.

*Relations.*—In the sole of the foot the tendons of the flexor longus digitorum, gether with the flexor accessorius and the lumbricales, are covered by the flexor evis digitorum ; the hinder part of the external plantar vessels and nerve being aced between. These tendons, with their additional muscles, conceal the ductor hallucis, the tendon of the flexor longus hallucis, the transversus pedis, e interosseous muscles, and the plantar arterial arch.

**The flexor longus hallucis** muscle (flexor longus pollicis pedis) arises om the lower two-thirds of the posterior surface of the fibula ; from the termuscular septum between it and the peronei ; and from the poneurosis common to it and the flexor longus digitorum, which covers e tibialis posticus. The muscular fibres, passing obliquely backwards nd downwards, end in a tendon on the posterior surface of the muscle. his tendon traverses a groove on the lower end of the tibia, on the back f the astragalus and the under surface of the sustentaculum tali, being ound down to those bones by a fibrous sheath lined by synovial memrane. Thence passing forwards and inwards, in the sole of the foot, it gives off a slip to the tendon of the flexor longus digitorum, by which it is crossed, and proceeds in a fibrous sheath over the first phalanx of the great toe to be inserted into the base of the terminal phalanx.

*Relations.*—This muscle is concealed for the most part by the soleus, a small art only on the outer side of the tendo Achillis being covered by the fascia of the eg. Externally it is in contact with the peronei, and internally with the posterior ibial vessels and nerve. It rests upon the fibula and tibialis posticus, and coneals the peroneal vessels. Behind the ankle the tendon of this muscle is eparated from that of the flexor longus digitorum by an interval of more than alf an inch. in which are placed the posterior tibial vessels and nerve. In the ole it is covered by the abductor hallucis and the plantar fascia ; it is also rossed by the plantar vessels and nerves as well as by the tendon of the long exor of the toes. It rests upon the flexor brevis hallucis.

*Varieties.*—This muscle is liable to very few variations, except in the mode of nion of its tendon with that of the flexor longus digitorum which is exceedingly ariable. In almost every case a slip is given from the flexor hallucis to the exor digitorum : and very frequently (1 in 6, Turner, Wood ; 1 in 4. Schulze) an dditional slip proceeds from the flexor digitorum to the flexor hallucis. Comlete separation of the tendons is very rare. This slip from the flexor hallucis ost frequently passes to the second and third toes, but it may pass to the second nly, or to all the four outer toes.

The *peroneo-calcaneus internus* is a small muscle described by Macalister as he probable homologue of the pronator quadratus of the arm. It arises below the exor longus hallucis from the back of the fibula, behind the external malleolus, nd passes over the sustentaculum tali in the groove with the flexor hallucis to e inserted into a tubercle on the os calcis.

**The tibialis posticus** muscle, placed beneath the two long flexor muscles, arises from the posterior surface of the interosseous membrane ; rom the outer portion of the posterior surface of the tibia, extending rom the superior tibio-fibular articulation to the middle of the bone ; rom the whole inner surface of the fibula ; and slightly from the aponeuosis covering it. The fleshy fibres pass to a tendon which, commencing bove in the centre of the muscle, descends along its inner border, beomes free at the level of the lower tibio-fibular articulation, and gains the innermost groove at the back of the internal malleolus, where it is contained in a fibrous sheath and surrounded by synovial membrane. It then inclines forwards, and ends by being inserted into the tubercle of the navicular bone, sending offsets forwards to the three cuneiform bones, to the cuboid, and to the bases of the second, third and fourth metatarsal bones, as well as a thin process backwards to the sustentaculum tali. Near its insertion the tendon contains a sesamoid fibro-cartilage, occasionally a bone, as it lies beneath the head of the astragalus.

*Relations.*—The posterior surface of the tibialis posticus is in contact with the long flexors of the toes and the posterior tibial and peroneal vessels, while at the upper end the anterior tibial vessels are directed forwards between its attachments to the two bones. In the lower part of the leg the muscle crosses obliquely inwards beneath the flexor longus digitorum, and its tendon becomes superficial for a short distance, lying close to the hinder border of the internal malleolus. In the foot it is covered by the abductor hallucis, and it rests against the inferior calcaneo-navicular ligament which separates it from the head of the astragalus.

*Varieties.*—These are rare. An additional muscle has been seen occasionally arising from the back of the tibia below the flexor digitorum, and inserted into the capsule of the ankle-joint or into the annular ligament. This is the *tensor of the capsule of the ankle-joint* of Henle and Linhart, or the *tibialis secundus* of Bahnsen.

**Nerves.**—The gastrocnemius, plantaris and popliteus, are supplied by the internal popliteal nerve. The soleus receives one branch from the internal popliteal nerve and another from the posterior tibial. The flexor longus digitorum, flexor longus hallucis and tibialis posticus derive their nerves from the posterior tibial.

## MUSCLES AND FASCIÆ OF THE FOOT.

FASCIÆ.—The **fascia of the dorsum of the foot** is reduced to a thin membrane prolonged from the anterior annular ligament over the extensor tendons. Beneath it, deeper layers of fascia are placed over the short extensor of the toes and the interosseous muscles.

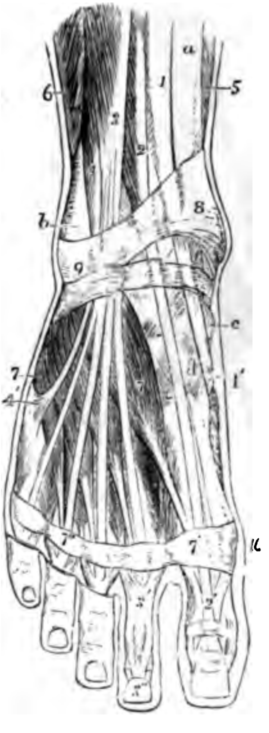
The **superficial fascia of the sole** resembles that of the palm of the hand. It forms a thick cushion, especially over the bony prominences, and consists mainly of small lobules of fatty tissue bound down by numerous fibrous bands which pass vertically from the skin to the deep fascia.

The **deep fascia of the sole**, or **plantar fascia**, consists of a central and two lateral portions, which are marked off from each other by superficial grooves, indicating the position of intermuscular septa. The *inner* portion, thinner and looser than the others, invests the abductor hallucis, and is continuous round the inner border of the foot with the dorsal fascia and with the lower fibres of the internal annular ligament. The *outer* part covers the abductor minimi digiti, is much stronger, and forms a particularly thick band between the outer tubercle of the os calcis and the base of the fifth metatarsal bone. It is continuous round the outer border of the foot with the dorsal fascia, and sends a thin prolongation forwards over the insertion of the abductor and the short flexor muscles of the little toe. The *central* portion is exceedingly strong, and is composed of dense white glistening fibres, the greater number of which run longitudinally from the os calcis to the roots of the toes. It is narrow and thick behind, where it is attached to the inner tubercle of the os calcis, immediately below the origin of the flexor brevis digitorum, with which muscle it is closely connected. It becomes broader and thinner as it extends forwards, and near the heads of the metatarsal bones it divides into five processes, one passing to each of the toes. In the intervals between the processes a thin membrane composed of transverse fibres covers the lumbricales muscles and the digital nerves. The rangement of the processes is identical with that of the corresponding rt of the palmar fascia, fibres being sent to the digital sheaths, supercial transverse ligament and skin, as well as deep processes on each de of the flexor tendons to the transverse metatarsal ligament.

The two *intermuscular septa* which are given off between the middle nd lateral portions of the plantar fascia pass deeply into the sole of the ot ; they separate the flexor brevis digitorum from the abductor allucis on the inner side, and from the abductor minimi digiti on the ter side, and give partial origin to each of these muscles.

The *superficial transverse ligament of the toes* is a thin band of fibres ntained in the folds of skin limiting the interdigital clefts, and nnected to the subjacent sheaths of the tendons. Like the transverse tatarsal ligament, it differs from the responding structure in the hand in ng attached to all five digits.

Fig. 188.



g. 188.—SUPERFICIAL MUSCLES AND TENDONS ON THE DORSUM OF THE FOOT AND LOWER PART OF THE FRONT OF THE LEG (after Bourgery). ½

, tibia ; *b*, fibula ; *c*, navicular bone ; *d*, inal cuneiform bone ; 1, 1′, tibialis anticus ; 2, nsor proprius hallucis ; 2′, its expansion on the sum of the great toe ; 3, extensor communis torum dividing into its four tendons for the ; 3′, its expansion, and 3″, final insertion (upon second toe) ; 4, peroneus tertius ; 4′, its exded insertion on the base of the fifth metatarsal e ; 5, soleus ; 6, peroneus brevis ; 7, extensor ris digitorum ; 7′, 7″, placed on the transverse d of aponeurosis, marks the first and fourth lons of the extensor brevis muscle ; 8, 9, part of anterior annular ligament ; 10, 11, a transverse d of the dorsal fascia of the foot.

MUSCLES.—On the dorsum of the foot, ides the tendons continued from the scles of the front of the leg, one short scle is present, viz., the extensor brevis itorum. In the sole the muscles are ich more numerous, and are described four layers as they are met with in the rse of a dissection.

**The extensor brevis digitorum dis** arises from the fore part of the per and outer surfaces of the os calcis, front of the groove for the peroneus evis muscle, and from the lower band of the anterior annular ligament. divides into four tapering slips, each of which terminates in a tendon ; e first or most internal of these is inserted separately into the dorsal rface of the first phalanx of the great toe at its tarsal extremity ; and e other three become severally united to the outer border of the ndons of the long extensor proceeding to the three next toes.

*Relations.*—It crosses the dorsum of the foot somewhat obliquely, resting on e tarsus and metatarsus, and lying beneath the tendons of the peroneus tertius d long extensor of the toes. Its inner slip also crosses the dorsal artery of the ot and the anterior tibial nerve.

*Varieties.*—The tendons of this muscle vary considerably both as to number and position. they may be reduced to two. or one of them may be doubled. or an additional slip may pass to the little toe. The innermost portion of the muscle is commonly separate much farther back than the other slips, and is described by many anatomists as a distinct muscle under the name of *extensor brevis hallucis.*

The FIRST LAYER OF MUSCLES OF THE SOLE includes the short common flexor of the toes, and the abductors of the great and little toes.

The **flexor brevis digitorum,** or **flexor perforatus,** arises by a small pointed attachment from the fore part of the inner tubercle of the calcaneum. from the deep surface of the plantar fascia for about two inches forwards, and from the intermuscular septum on each side. The muscle terminates in four slender tendons which are inserted into the second phalanges of the four outer toes. Each tendon prior to its insertion divides and gives passage to the tendon of the long flexor, in a manner precisely similar to the arrangement of the tendons of the flexor sublimis and flexor profundus muscles of the hand.

Fig. 189.

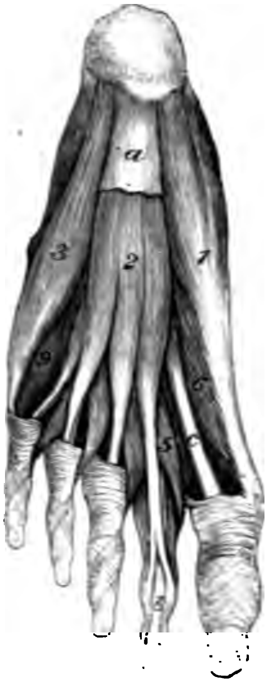


Fig. 189.—FIRST LAYER OF MUSCLES OF THE SOLE. ½

*a*, plantar fascia; *b*, tendon of flexor longus digitorum to second toe; *c*, tendon of flexor longus hallucis; 1. abductor hallucis; 2, flexor brevis digitorum; 3, abductor minimi digiti; 5, first lumbricalis; 6, inner head of flexor brevis hallucis; 9, flexor brevis minimi digiti.

*Relations.*—This muscle lies between the abductor hallucis and abductor minimi digiti. and is covered by the plantar fascia: it conceals the flexor accessorius. with the tendons of the flexor longus digitorum. and the external plantar vessels and nerve.

*Varieties.*—The slip of this muscle to the little toe. which is regularly much smaller than the others. is frequently wanting; or it may be replaced by a small fusiform muscle arising from the outer side of the long flexor tendon. or more rarely from the flexor accessorius. On the other hand, the muscle has been seen with five tendons, two passing to the second toe.

The **abductor hallucis** muscle (abd. pollicis pedis) arises from the inner part of the larger tubercle of the calcaneum, from the internal annular ligament, from the septum between it and the flexor brevis digitorum, and from the plantar fascia covering it. The fleshy fibres end in a tendon which, after being joined by fibres of the internal head of the flexor brevis hallucis, is inserted into the inner border of the base of the first phalanx of the great toe.

*Relations.*—It is covered by the thin internal division of the plantar fascia. Its deep surface is in contact with the tendons of the tibialis posticus, and long flexor muscles, with the flexor brevis hallucis, and with the plantar vessels and nerves.

*Varieties.*—The abductor hallucis occasionally sends a slip to the base of the first phalanx of the second toe. Its tendon of insertion is sometimes joined by a

:ular slip springing from the skin on the inner border of the foot, somewhat :ont of the inner ankle ; but this is not so frequent as the cutaneous slip of :orresponding muscle of the hand.

he **abductor minimi digiti** muscle has a wide origin behind, ı the front of both tubercles on the under surface of the os calcis, ı the external intermuscular septum, and from the deep surface of band of the plantar fascia which extends from the external tubercle he base of the fifth metatarsal bone. The fleshy fibres end in a

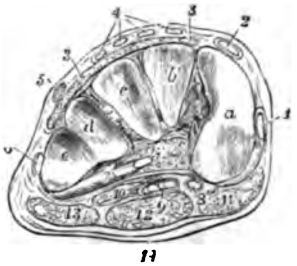


Fig. 190.

190.—TRANSVERSE SECTION OF THE RIGHT )T BETWEEN THE TARSUS AND METATARSUS. T. ½

*b*, *c*, articular surfaces of the internal, middle, xternal cuneiform bones ; *d* and *e*, the surfaces e cuboid bone for the fourth and fifth meta- l bones ; between these bones are seen the g interosseous ligaments which bind them her ; 1, slip of the tendon of the tibialis ıs, which passes on to its insertion into the metatarsal bone ; 2, tendon of the extensor ius hallucis ; 3, slip of the extensor brevis rum to the great toe ; 3′, remainder of the sor brevis digitorum ; 4, slips of the extensor s digitorum ; 5, peroneus tertius ; 6, peroneus s ; 7, peroneus longus cut obliquely where it is emerging from its sheath below the d bone ; 8, tendon of the flexor longus hallucis ; 9, tendon of the flexor longus rum, with the slip from the flexor hallucis ; 10, flexor accessorius ; 11, abductor cis ; 12, flexor brevis digitorum ; 13, abductor minimi digiti.

lon which, after gliding along a smooth depression on the inferior ace of the base of the fifth metatarsal bone, is inserted into the outer of the base of the first phalanx of the little toe.

*lations.*—The muscle is covered by the plantar fascia. Its deep surface is ntact with the outer head of the flexor accessorius, the long plantar liga- ;, the peroneus longus tendon, and the flexor brevis minimi digiti.

*riety.*—The *abductor ossis metatarsi quinti* is an occasional muscle which s from the external tubercle of the os calcis, and is inserted into the spur- process of the fifth metatarsal bone in common with, or beneath the outer in of the plantar fascia. It may be adherent to the abductor minimi digiti, it has been seen inserted into the middle or even the anterior part of the tarsal bone. It occurs nearly once in every two subjects (Wood, Macalister).

he SECOND LAYER OF MUSCLES OF THE SOLE is constituted by the ons of the flexor longus digitorum and flexor longus hallucis, ther with the flexor accessorius and lumbricales, all of which have . described in the last section (pp. 257—259).

he THIRD LAYER OF MUSCLES comprises the short flexor and adductor ıe great toe, the transversus pedis, and the short flexor of the little toe.

he **flexor brevis hallucis** (fl. brev. pollicis pedis) arises by a flat inous process from the inner border of the cuboid bone, and by a ıd band from the offset of the tibialis posticus tendon which passes ıe middle and outer cuneiform bones. The muscular part is single narrow behind, but in front it divides so as to form two bellies or ls which are inserted by tendinous fibres, one into the inner border of base of the first phalanx in union with the abductor hallucis, the r into the outer border in union with the adductor. A sesamoid : is developed in each of the heads.

*Relations.*—This muscle is in great part covered by the abductor hallucis and the common flexors of the toes, while the tendon of the flexor longus hallucis runs in the groove between its heads.

*Varieties.*—The origin of the flexor brevis hallucis is subject to considerable variation: it often receives fibres from the os calcis or long plantar ligament, and the attachment to the cuboid is sometimes wanting. The muscle has been seen sending a slip to the first phalanx of the second toe.

The **adductor hallucis** (add. pollicis pedis), placed obliquely in the sole of the foot, and forming a thick fleshy mass, arises from the tarsal extremities of the third and fourth metatarsal bones, and from the sheath of the peroneus longus muscle; narrowing as it passes forwards, it is inserted, conjointly with the external head of the flexor brevis hallucis, into the base of the first phalanx of the great toe.

Fig. 191.

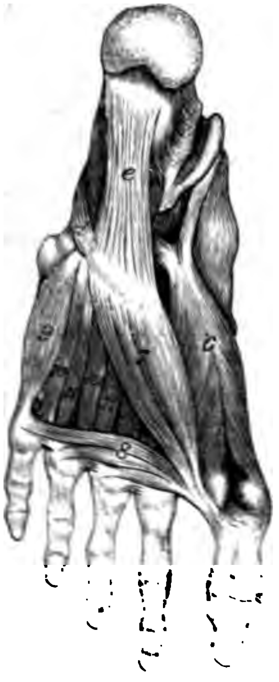


Fig. 191.—Third layer of muscles of the sole. ½

*d*, tendon of peroneus longus; *e*, long plantar ligament; 6, flexor brevis hallucis; 7, adductor hallucis; 8, transversus pedis; 9, flexor brevis minimi digiti; 10, 10, second and third plantar interosseous muscles; 11, 11, third and fourth dorsal interosseous muscles.

*Relations.*—At its inner side it is connected with the flexor brevis hallucis; its deep surface rests upon the second, third and fourth metatarsal bones and the intervening interosseous muscles. The deep parts of the external plantar artery and nerve pass inwards beneath its outer border.

*Varieties.*—A slip has been observed from this muscle also to the base of the first phalanx of the second toe. The *opponens hallucis* is a muscle frequently found (Macalister). It usually comes off as a slip from the adductor, and is inserted into the metatarsal bone of the great toe. It occurs in some apes.

The **transversus pedis** consists of narrow fasciculi of fleshy fibres, placed transversely under cover of the flexor tendons, and arising from the inferior metatarso-phalangeal ligaments of the three outer toes, and from the transverse metatarsal ligament. The fibres of the muscle pass transversely inwards, and are inserted in union with the adductor hallucis into the first phalanx of the great toe.

*Relations.*—Superficially it is crossed by the flexor tendons and by the digital nerves: its deep surface rests upon the heads of the metatarsal bones, the interosseous muscles and the digital vessels.

*Varieties.*—The slip from the little toe is frequently absent: absence of other slips or of the entire muscle has also been recorded. This muscle is described by many anatomists as a second head of the adductor hallucis.

The **flexor brevis minimi digiti** arises by tendinous fibres from the base of the fifth metatarsal bone, and from the sheath of the peroneus longus, and terminates in a tendon which is inserted into the base and external border of the first phalanx of the little toe.

*Relations.*—It is covered partly by the abductor minimi digiti, partly by the plantar fascia. It rests upon the fifth metatarsal bone, and its tendon blends at its insertion with the inferior metatarso-phalangeal ligament.

*Variety.*—The *opponens minimi digiti* is a small additional muscle frequently found at the inner border of the flexor brevis, of which, indeed, it appears to be a slip. It is united to the flexor brevis for some distance from its origin, but is inserted separately into the anterior half of the fifth metatarsal bone. It is regarded as normal by Henle, Krause, and others.

The FOURTH LAYER OF THE SOLE includes the dorsal and plantar interosseous muscles, with which the tendons of the tibialis posticus and peroneus longus are sometimes also enumerated.

The **interosseous muscles** of the foot, like those of the hand, are seven in number, three plantar and four dorsal; the plantar are visible only from the under side, while the dorsal muscles are visible both from above and below. Two muscles are found in the second, third and fourth spaces, but only one in the first.

Fig. 192.

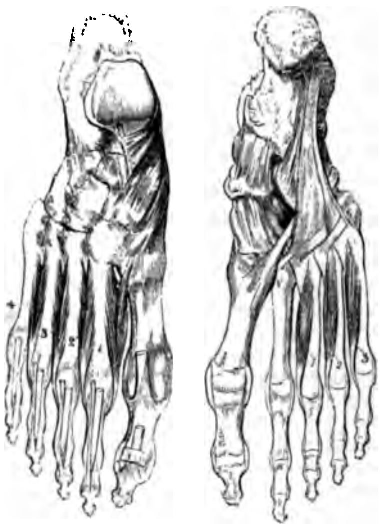


Fig. 192, A.—THE DORSAL INTEROSSEOUS MUSCLES FROM ABOVE. ½

1, 2, 3, 4, the several dorsal interosseous muscles in order from within outwards.

B.—THE PLANTAR INTEROSSEOUS MUSCLES FROM BELOW.

1, 2, 3, first, second, and third plantar interosseous muscles; this figure also shows the long and short plantar ligaments, and the insertion of the tendon of the peroneus longus into the first metatarsal bone.

The *dorsal interosseous* muscles lie one in each interspace. Each muscle arises by two heads from the adjacent sides of two metatarsal bones; their muscular fibres are attached pennately on the two sides of a central tendon which is inserted partly into the base of the first phalanx and partly into the extensor aponeurosis of the toe to which each belongs. The first two are inserted one on each side of the second toe; the third and fourth are severally inserted on the outer sides of the third and fourth toes. At the proximal end of each muscle there is an interval between the two origins giving passage to perforating arteries as in the hand.

The *plantar interosseous* muscles arise from the inner and under surfaces of the third, fourth and fifth metatarsal bones, and are severally inserted, in a manner similar to the dorsal interossei, partly into the inner sides of the first phalanges of the third, fourth and fifth toes, and partly into the extensor tendons of these toes.

**Nerves.**—The extensor brevis digitorum is supplied by the anterior tibial nerve. Of the muscles of the sole the flexor brevis digitorum, the abductor and flexor brevis hallucis, and the two inner lumbricales are supplied by the internal plantar nerve; all the others, including the flexor accessorius and the two outer lumbricales, are supplied by the external plantar nerve.

**Actions of the Muscles of the Leg and Foot.**—There is only one muscle of the leg, viz., the *popliteus*, which acts on the knee-joint alone. Its principal action is that of a rotator inwards of the leg, but it also assists in bending the knee. It comes into play especially in the commencement of flexion, producing the inward rotation of the tibia (or outward rotation of the femur), which is essential to that stage of the movement.

It may here be observed that owing to the difference in the direction of the bend at the ankle, as compared with that at the wrist-joint, some confusion is apt to arise in the description of the action of the muscles of the leg upon the foot. As it is obvious from morphological considerations that the anterior surface of the leg and the dorsal surface of the foot belong to the general *extensor* surface of the limb, corresponding with the back of the forearm and the dorsum of the hand; and that the back of the leg and the sole of the foot belong in the same way to the general *flexor* surface corresponding with the front of the forearm and the palm of the hand, the foot being in a position of over-extension, it follows that the muscles on the anterior aspect of the leg are really extensors, and that their action in moving the foot so as to approximate the toes to the front of the leg merely increases the over-extension; while, on the other hand, the muscles on the posterior aspect of the leg are really flexors, and their action in straightening the ankle-joint is to reduce merely this over-extension by an opposite movement of flexion. Nevertheless, it has been customary to apply the name of flexion to the action of raising the foot on the front of the leg, and that of extension to its depression. In the following description the usual terms are employed.

The *gastrocnemius* acts both as a flexor of the knee and an extensor of the ankle-joint. When the anterior muscles of the leg fix the ankle-joint, it is fitted to act as a flexor of the knee: when the knee is fixed either by being placed in complete extension or by the sustained action of the extensor muscles, the gastrocnemius acts entirely on the foot, and combines with the *soleus* in lifting the heel from the ground, and in raising the body on the toes.

The *tibialis anticus* and *peroneus tertius* are flexors of the ankle; the *tibialis posticus* and *peroneus longus* and *brevis* are extensors. The two tibial muscles acting together produce the movement of inversion of the foot, in which action they are aided by the flexors of the toes. The three peronei and the extensors of the toes draw the foot upwards and outwards, and thus produce the movement of eversion. The peroneus longus, in crossing the foot inferiorly, strengthens the transverse arch formed by the metatarsal bones and anterior range of tarsal bones; especially when that arch is pressed upon by the weight of the body falling on the balls of the toes, as in stooping with bent knees.

The *flexor* and *extensor muscles* of the toes, including the *lumbricales* and *interosseous muscles*, act like the corresponding muscles in the hand. The direction of the flexor longus digitorum is, however, modified by the *flexor accessorius*, so as to bring its line of action into the direction of the middle of the foot and of the short flexor. The tibialis posticus and the flexors of the toes give important assistance to the ligaments and the plantar fascia in supporting the longitudinal arches of the foot.

## MORPHOLOGY OF THE LIMB-MUSCLES.

It has already been mentioned (p. 188) that the muscles of the limbs and limb-girdles are primarily derived mainly from the ventro-lateral division of the epaxial set of muscles. In the case of the upper limbs there are no muscles of hypaxial origin, but in the lower limb there are at least two muscles which may be regarded as prolongations outwards from the hypaxial set, one passing to its inner and anterior (preaxial) aspect (psoas), the other to its posterior and outer (postaxial) aspect (pyriformis). These two muscles are consequently without homologues in the upper limbs. As each limb begins bud-like to project from the side of the embryo, it may be supposed to receive an enveloping sheath of muscle from the side of the body (Humphry). This sheath is at first a simple nfundibulum, but it gradually extends in length with the growth of the limb, nd becomes segmented, *pari passu*, with the segmentation of the hard parts. The deeper fibres of the sheath are restricted to passing from one segment to the ext, while the superficial fibres are frequently found to pass over one segment ltogether to more distal parts. Humphry holds that of the three layers into which the trunk portion of the ventro-lateral muscle divides, two layers may be raced into its appendicular segments, corresponding respectively to the external blique and superficial portion of the internal oblique layers (see later the morphology of the trunk-muscles). In the upper limb, from the greater freedom of novement of the girdle, and from its more superficial position, the first segment f the muscular sheath is longer, and its constituent parts more easily recognised han in the case of the trunk-girdle muscles of the lower limb, which are not ifferentiated to the same extent from the trunk-muscles. Traced to the shoulder-irdle, the superficial layer of trunk-limb muscles is found to divide into three rincipal masses. Anteriorly are the pectorals; superiorly and posteriorly are he cleido-mastoid and trapezius, the latter being continued to the bone of the rm as the deltoid; and inferiorly and posteriorly the latissimus dorsi. Beneath he trapezius are the rhomboids, and on the deeper surface of the latissimus dorsi re its occasional scapular portion and the teres major, all of which appear to be ormed in the deeper parts of this layer. The muscles of this layer are frequently ound to some extent united together either as varieties in man, or as regular tructures among some of the lower animals, and it is interesting to note that any of the varieties hitherto described, seem to be reversions so far towards a niform type. Thus in Lepidosiren the pectoralis major and latissimus dorsi are lended together at their margins, so as to form one continuous muscle; and in an the frequently recurring axillary arches or loops of muscular fibres which ass from one muscle to the other across the axillary space may point to an imperfectly segmented condition. Again, the pectoralis major is always united in an with the superficial fibres of the external oblique, but in the cryptobranch it continuous with it in its entire thickness. The cleido-mastoid, which in man in close relation with the clavicular portion of the pectoralis major, being only parated from it by the clavicle, runs with the anterior part of the trapezius nto the deltoid in those animals in which the clavicle is deficient, forming a phalo-humeral muscle.

The trunk-limb muscles of the deep layer form a much less complete layer an those of the superficial. They are attached to the shoulder-girdle in two ets. In front of the glenoid cavity, and attached to the coracoid, is the costoracoid muscle (in man called subclavius from its more common place of ttachment); and behind the glenoid cavity, attached to the scapula, are the sto-scapular muscles, viz., the serratus magnus, together with the levator apulæ. Besides these there is the slender omo-hyoid from the front of the yoidean arch to the upper border of the scapula.

In the lower limb the ventro-appendicular muscles are represented for the ost part by the oblique abdominal muscles, only those parts of the muscles hich pass from the girdle to the limb being found distinct. The gluteus maximus most closely represents the latissimus dorsi, and is similarly inserted into he postaxial border of the limb. The pectoralis corresponds most nearly with the racilis, and the trapezio-deltoid with the anterior part of the external oblique nd pectineus. The gracilis and pectineus arise near each other, and are inserted nto the preaxial border of the limb. The pectineus, however, seems to consist f two parts, of which the inner may be related to the subclavius, and the outer the great pectoral and deltoid.

All the other muscles of the limbs are *intrinsic*, and in their relation to the veral segments are arranged in groups which may in the main be compared omologically with each other. These groups are situated chiefly on the ventral nd dorsal aspects, or on the preaxial and postaxial borders of the limbs, and the uscles of which they are composed are respectively flexors and extensors, or rotractors and retractors.

In attempting. however, to institute a homological comparison between the ndividual muscles of the various segments in the two limbs, it will be necessary to bear in mind, first, the great difference in the attitude of the bones of the proximal segments, the flexor surface in the upper limb being thrown forwards as if by an outward twist, and in the lower limb the flexor surface being turned backwards as if by an inward twist of the proximal segments; and farther, the preponderance in the second segment of the lower limb of the preaxial bone (tibia) over the postaxial (fibula) as opposed to the greater development of the upper end of the postaxial bone of the arm (ulna) over the preaxial (radius). These differences are apt to lead to confusion and difficulty, inasmuch as the insertions of homologous muscles are in some cases very different in the two limbs. In such cases the determination of the homologies may be greatly assisted by the observation of the more constant origins. For example, the great extensor of the forearm is inserted into the postaxial ulna, while in the leg the quadriceps is inserted into the preaxial tibia; and yet few will doubt the justness of the homological comparison between them.

In the distal segments of both limbs the muscles, though more numerous, become shorter and more uniform in their disposition, and hence the homology becomes more apparent between the muscles of the hand and foot, than in those situated nearer the roots of the limbs.

From what has been said it appears that considerable difficulty still prevails in the determination of the muscular homologies of the upper and lower limbs, especially in their proximal segments and attachment to the trunk, and the comparison of these muscles cannot, therefore, be minutely followed out. But the following table may be useful to the student of human anatomy, as presenting what appear to be the most probable views of the muscular relations in the upper and lower limbs, and as indicating the bearing upon such views of some facts in comparative anatomy as well as of some of the varieties mentioned in the previous description of the individual muscles. (Upon this subject consult the works of Humphry, Mivart, Rolleston and Huxley, already quoted at pp. 131 and 188.)

## TABLE OF MUSCULAR HOMOLOGIES IN THE UPPER AND LOWER LIMBS.

### I. MUSCLES PASSING FROM TRUNK TO LIMBS OR THEIR GIRDLES.

| *Upper Limb.*[*] | *Lower Limb.* |
|---|---|
| 1. Trapezius | 1, 1*a*, 1*b*. Lumbar aponeurosis and external oblique. |
| 1*a*. Cleido-mastoid | |
| 1*b*. Rhomboids | |
| 2. Levator scapulæ | 2, 2*a*. Quadratus lumborum.<br>Internal oblique. |
| 2*a*. Serratus magnus | |
| 3. Latissimus dorsi | 3, 3*a*. Gluteus maximus. |
| 3*a*. Teres major | |
| 4. Pectoralis major | 4. Gracilis. Part of Pectineus? |
| 4*a*. Pectoralis minor | 4*a*. ? |
| 4*b*. Subclavius (second pectoral of birds, Rolleston)? | 4*b*. Inner or deep head of Pectineus, supplied by obturator nerve (Rolleston)? |
| 5. Omohyoid | 5? |

### II. MUSCLES PASSING MAINLY FROM GIRDLE TO LIMB.

| Upper Limb | | Lower Limb |
|---|---|---|
| 6. Deltoid | 6*a*. Scapular part | 6*a*. Tensor vaginæ femoris and Sartorius. |
| | 6*b*. Clavicular part | 6*b*. Pectineus, outer head supplied by anterior crural nerve (Rolleston). |
| 7. Supraspinatus | | 7. Obturator internus? |

---

[*] The numbers affixed to the several muscles in the two columns are intended merely as a means of facilitating the reference from one to the other, the upper limb being taken as the standard of comparison. The names of muscles printed in italics are those of varieties more or less frequently found in human anatomy.

| | |
|---|---|
| Infraspinatus | 8. Iliacus. |
| Teres minor | 8*a*. *Iliacus minor* (Luschka). |
| Subscapularis | 9. Gluteus medius.<br>Gluteus minimus. |
| Coraco-brachialis<br>*a*, *b*, *c*. *Upper*, middle and *lower* parts | 10*a*, *b*, *c*. Three Adductors, with perhaps Obturator externus. |
| Biceps flexor cubiti<br>*a*. Glenoid head<br>*b*. Coracoid head | 11*a*, *b*. Ischial head of Biceps cruris.<br>Semimembranosus.<br>Semitendinosus. |
| *c*. *Humeral head*<br>Brachialis anticus | 11*c*, *d*. Femoral head of Biceps femoris. |
| Triceps extensor cubiti | 12. Quadriceps extensor cruris. |
| *a*. Scapular head | *a*. Rectus femoris. |
| *b*. External humeral head | *b*. Vastus externus. |
| *c*. Internal humeral head | *c*. Vastus internus.<br>Crureus. |

### III. MUSCLES PASSING OVER ELBOW AND KNEE-JOINTS AND ACTING ON THE RELATIVE POSITION OF THE BONES OF THE FOREARM AND LEG.

| *Upper Limb.* | *Lower Limb.* |
|---|---|
| 13. Supinator radii longus | 13. ? |
| 14. Supinator radii brevis | 14. ? |
| 15. Pronator radii teres | 15. Popliteus. |
| 16. Pronator quadratus | 16. *Peroneo-calcaneus internus* (Macalister). |

### IV. MUSCLES PASSING OVER WRIST AND ANKLE-JOINTS.

#### A. *To the carpus and metacarpus or to the tarsus and metatarsus.*

| | |
|---|---|
| 17. Extensor carpi radialis longior<br>17a. Extensor carpi radialis brevior | 17. ? |
| 18. Extensor ossis metacarpi pollicis | 18. Tibialis anticus. |
| 19. Extensor carpi ulnaris | 19. Peroneus tertius. |
| 20. Flexor carpi radialis | 20. Gastrocnemius. |
| 21. Palmaris longus | 21. Plantaris. |
| 22. Flexor carpi ulnaris | 22. Peroneus longus and brevis. |
| 23. *Radio-carpus* | 23. Tibialis posticus. |

#### B. *To the digital phalanges.*

| | |
|---|---|
| 24. Extensor com. digit. longus | 24. Extensor com. digit. long. |
| 25. Extensor secundi internod. poll. | 25. Extensor prop. hallucis. |
| 26. Extensor primi internod. poll. | 26. First slip of ext. brevis digit. |
| 27. Extensor indicis | 27. Second slip of ext. brevis digit. |
| 28. Extensor minimi digiti | 28. Part of ext. long. digit. |
| 29. Flexor sublimis digitorum | 29. Soleus and flexor brevis digitorum. |
| 30. Flexor profundus digitorum | 30. Flexor longus digitorum. |
| 31. Flexor longus pollicis | 31. Flexor longus hallucis. |

### V. MUSCLES CONFINED TO THE HAND AND FOOT.

| | |
|---|---|
| Tendons of ext. secundi internod. pollicis and indicis, and *ext. brevis digit.* | 32. Extensor communis digitorum brevis. |
| Abductor pollicis | 33. Abductor hallucis. |
| Flexor brevis pollicis | 34. Flexor brevis hallucis. |
| *a*. Part of inner head | *a*. Adductor hallucis. |
| Opponens pollicis | 35. *Opponens hallucis.* |

| | | | |
|---|---|---|---|
| [illegible]. | Adductor pollicis . . . | 36. | Transversus pedis. |
| 37. | Tendons of flexor sublimis digitorum . . . . . | 37. | Flexor brevis digitorum. |
| 38. | Palmaris brevis . . . . | 38. | |
| 39. | Abductor minimi digiti . . | 39. | Abductor minimi digiti. |
| 40. | Flexor brevis minimi digiti . | 40. | Flexor brevis minimi digiti. |
| 41. | Opponens minimi digiti . . | 41. | *Opponens minimi digiti.* |
| 42. | Interossei, dorsal and palmar . | 42. | Interossei, dorsal and plantar. |
| | *a*. Radialis secundi digiti (dors.) | | *a*. Tibialis secundi digiti (dors.). |
| | *b*. Ulnaris sec. dig. (palm.) . | | *b*. Fibularis sec. dig. (dors.). |
| | *c*. Radialis medii (dors.) . . | | *c*. Tibialis tertii (plant.). |
| | *d*. Ulnaris medii (dors.) . . | | *d*. Fibularis tertii (dors.). |
| | *e*. Radialis quarti (palm.) . | | *e*. Tibialis quarti (plant.). |
| | *f*. Ulnaris quarti (dors.) . . | | *f*. Fibularis quarti (dors.). |
| | *g*. Radialis quinti (palm.). . | | *g*. Tibialis quinti (plant.). |
| 43. | Lumbricales . . . | 43. | Lumbricales. |

## III.—MUSCLES AND FASCIÆ OF THE HEAD AND NECK.

### EPICRANIAL REGION.

FASCIA.—The **superficial fascia** is little developed on the head and neck generally, and is in great measure blended with structures described under other names. A layer of considerable firmness, however, intervenes between the aponeurosis of the occipito-frontalis muscle and the skin, uniting them closely together: from the surface of the occipital part of the muscle it becomes continuous with the superficial covering of the posterior muscles of the neck, and on each side of the epicranial aponeurosis it descends over the temporal fascia, and contains between its laminæ the external muscles of the ear, with the superficial temporal vessels and nerves.

MUSCLES.—Under the title of **occipito-frontalis** are comprised the occipital and frontal muscles, united together by a thin aponeurosis which extends over and covers the upper part of the cranium.

The **occipitalis** muscle, thin and subcutaneous, is attached inferiorly by short tendinous fibres to the external two-thirds, sometimes less, of the superior curved line of the occipital bone, and to the mastoid portion of the temporal bone above the attachment of the sterno-mastoid muscle. Its fleshy fibres, from one to two inches in length, are directed upwards, and terminate in distinct tendinous fibres, continuous with the epicranial aponeurosis. The interval between the muscles of opposite sides is occupied by the aponeurosis.

The **frontalis** muscle, larger and of a paler colour than the occipitalis, arises superiorly in a convex line from the epicranial aponeurosis between the coronal suture and the frontal eminence. Inferiorly the fibres terminate in the subcutaneous tissue at the root of the nose and along the whole length of the eyebrow, the inner fibres appearing to be continued into the pyramidalis nasi muscle, while the larger number interlace with those of the corrugator supercilii and orbicularis palpebrarum. The fibres are nearly vertical, running slightly inwards as they descend: the margins of the right and left muscles are united for some distance above the root of the nose, but are separated by an angular interval superiorly.

The **epicranial** or **occipito-frontal aponeurosis** extends over the upper surface of the cranium uniformly from side to side, without division. Posteriorly it is attached to the occipitales muscles, and to the protuberance and superior curved lines of the occipital bone, and anteriorly it terminates in the frontales muscles, while laterally it presents no distinct margin, but below the temporal line becomes thinner and less aponeurotic, and gives attachment to the superior and anterior auricular muscles. Its fibres are chiefly longitudinal, and are most distinctly tendinous where they give attachment to the occipitales muscles. Its outer surface is firmly bound to the skin by an abundant network of connective tissue, constituting the so-called superficial fascia, by the meshes of which the subcutaneous fat is divided into granules; while its deep surface glides upon the subjacent pericranium, to which it is loosely attached by a delicate areolar tissue devoid of fat.

*Varieties.*—Both parts of the occipito-frontalis are subject to variation in their development, and in their places of attachment. The occipitalis occasionally approaches the middle line, and is frequently broken up into separate parts: its outermost fibres are sometimes inserted into the back of the pinna, becoming continuous with the posterior auricular muscle. The frontalis may send slips from its inner part to the frontal, nasal, or superior maxillary bones, or into the levator labii superioris alæque nasi, or from its outer part to the external angular process of the frontal bone, all of which have been described as normal by different anatomists.

**Actions.**—By the contraction of the frontales muscles the eyebrows are elevated, the scalp drawn forwards, and the skin of the forehead thrown into transverse wrinkles; by the contraction of the occipitales muscles the scalp is drawn backwards; and by the alternate action of the frontales and occipitales muscles the scalp is moved forwards and backwards. In the majority of persons, however, there is only a partial control over the action of these muscles, limited to the elevation of the eyebrows and horizontal wrinkling of the forehead.

## AURICULAR MUSCLES.

Besides minute bundles of muscular fibres which pass from one part of the pinna to another, and which will be most conveniently described with that structure, there are attached to the external ear three larger, but still very slightly developed, muscles, which serve to move it as a whole.

The **auricularis superior** or **attollens auriculam,** the largest of the three, arises in the temporal region of the head from the epicranial aponeurosis. Its fibres are extremely delicate, and converge from a wide surface to be inserted by a compressed tendon into the anterior part of the helix and into the eminence on the inner surface of the pinna corresponding to the fossa of the antihelix.

The **auricularis anterior** or **attrahens auriculam,** scarcely separated from the preceding muscle, is pale and indistinct, and is attached to the thin lateral prolongation of the epicranial aponeurosis, from which it passes backwards to be inserted into the fore part of the helix.

The **auricularis posterior** or **retrahens auriculam** muscle consists of two or three fasciculi, which arise from the mastoid portion of the temporal bone by short aponeurotic fibres, and are inserted into the back part of the concha. The fibres are deeper in colour and more distinctly marked than in either of the other auricular muscles.

*Varieties.*—Of the auricular muscles the posterior and the anterior are subject to greater varieties than the superior, but all vary somewhat in the extent of their development, the posterior more frequently by an increase in the number

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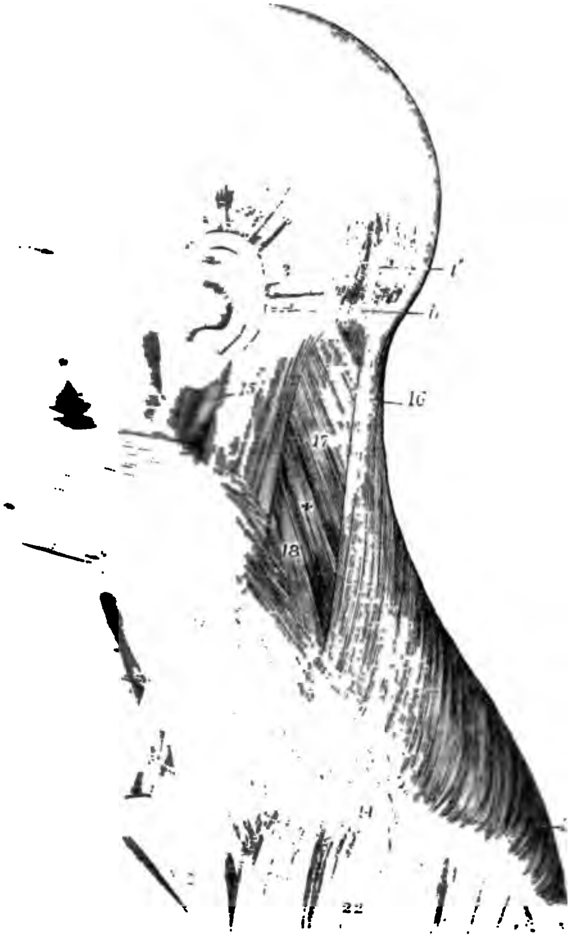


N THE LEFT SIDE OF THE HEAD AND NECK
A. T.

of the occipital bone; of the clavicle. 1, frontalis muscle; 2, attollens auriculam; 3, posterior auri pyramidalis nasi; 6, compressor naris; 8, its attachment to the zygomaticus minor; shadow, is seen a portion ; 12, depressor anguli oris; the risorius, and a ; 17, the upper part of the ster muscle; 19, the ster ; 20, ; 21 ular part; 22, deltoid.

of its slips, the anterior by a diminution of the volume and distinctness of its fibres. The origin of part of the retrahens is sometimes carried backwards to a variable extent along the superior curved line of the occipital bone. Cruveilhier describes as normal a deep anterior auricular muscle, passing from the zygomatic process to the outer surface of the tragus.

**Actions.**—The three auricular muscles respectively draw the pinna of the ear upwards, backwards, and forwards. In the majority of persons their action is not directly under voluntary control.

### MUSCLES OF THE EYELIDS AND EYEBROWS.

These are four in number, namely—the orbicularis palpebrarum and tensor tarsi, the levator palpebræ superioris, and the corrugator supercilii.

The **orbicularis palpebrarum** is a thin elliptical muscle closely adherent to the skin, surrounding the fissure between the eyelids and covering their surface, and spreading for some distance outwards on the temple, upwards on the forehead, and downwards on the cheek. It consists of two parts which differ somewhat in their arrangement and action. The central or *palpebral* portion is that part of the muscle which is contained in the eyelids. It is composed of thin pale fibres which arise from the upper and lower margins of the internal tarsal ligament, and pass outwards, describing a slight curve, to be inserted into the much less developed external tarsal ligament. A somewhat thicker fasciculus, which lies along the free margin of each lid, is distinguished as the *ciliary* bundle. The peripheral or *orbital* portion is larger, stronger, and of a deeper colour. Internally its fibres are attached to the inner part of the tarsal ligament, to the whole length of the nasal process of the superior maxilla, and to the inner part of the orbital arch of the frontal bone, while externally the fibres pass uninterruptedly from the eyebrow to the cheek, thus forming a series of concentric loops or, in the case of the more central fibres, nearly complete rings.

*Relations.*—The palpebral portion of the muscle is separated from the fibrous groundwork of the lids (tarsi) by the palpebral ligament. The orbital portion lies in its upper part over the frontal bone and the corrugator supercilii, and is closely connected with the insertion of the frontalis muscle: in its lower part it rests upon the superior maxillary and malar bones, and the origins of the elevator muscles of the upper lip and ala of the nose, and from both its inner and outer ends fibres are sent downwards to those muscles and to the skin of the cheek. These slips are described separately by Henle under the name of *malaris* muscle.

The *internal tarsal ligament* (tendon of the orbicularis, tendo palpebrarum) is a small white band which is often obscured by the fibres of the orbicularis muscle, but is rendered prominent by drawing the lids outwards. This ligament is about two lines in length and half a line in breadth, and is attached to the nasal process of the superior maxilla, in front of the lachrymal groove; thence it runs horizontally outwards to the inner commissure of the eyelids, where it divides into two thin fibrous lamellæ, which diverge and terminate on the tarsi. One surface of the ligament is subcutaneous; the other crosses the lachrymal sac, to which it is closely adherent, a little above the centre, and from it a process is given off, which passes on the posterior side of the sac to be attached to the crest on the lachrymal bone. The *external tarsal ligament* is a much weaker structure connecting the eyelids to the malar bone.

The **tensor tarsi** (musc. sacci lachrymalis, Horner) is regarded by

Fig. 194.

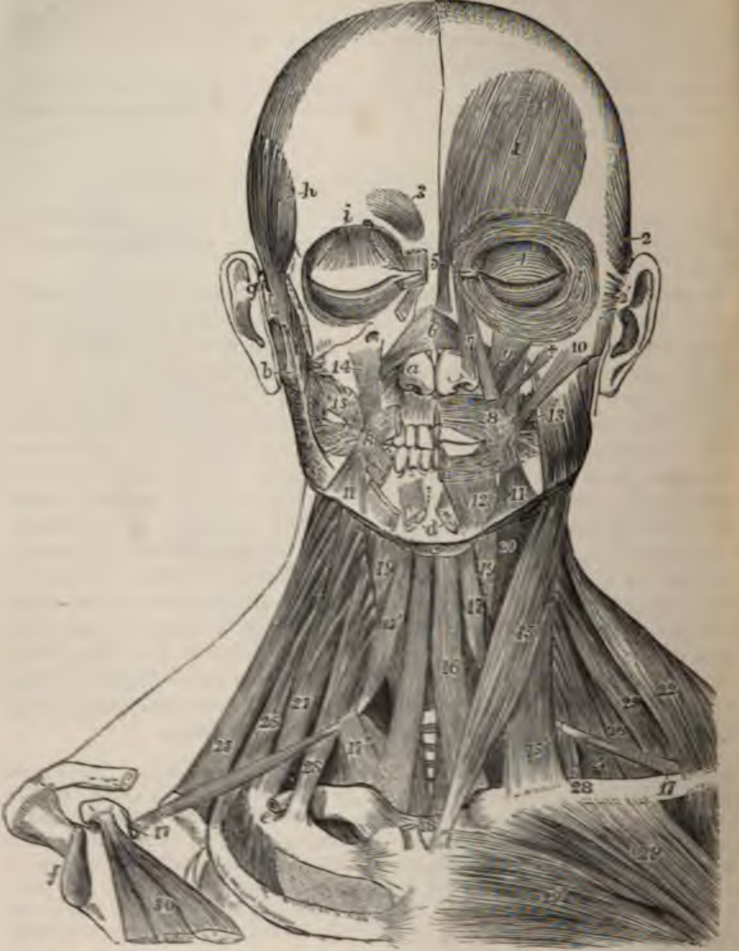


Fig. 194.—Superficial and deep muscles of the head and neck, from before (altered from Bourgery). (A. T.) $\frac{1}{3}$

On the left side, the platysma alone has been removed; on the right side, portions of the zygomatic arch and clavicle, the superficial muscles of the cranium and face, the masseter, trapezius, sterno-mastoid and pectoralis major muscles have been removed; a, lower lateral cartilage of the nose; b, upon the lobe of the right ear, points to the coronoid process of the lower jaw; c, body of the hyoid bone; d, symphysis of the lower jaw; e, upon the groove of the first rib, lying in which is the cut end of the subclavian artery; f, the glenoid cavity of the scapula; g, base of the right zygoma; h, temporal crest of the frontal bone; i, orbital arch; 1, frontalis muscle; 2, superior auricular; 2', anterior auricular; 3, corrugator supercilii; 4, orbital portion of the orbicularis palpebrarum; 4', palpebral portion; below i, the expanded insertion of the levator palpebræ superioris in the eyelid; 5, pyramidalis nasi; 6, insertion of the compressores naris on the dorsum of the nose; 7, levator labii superioris alæque nasi; 8, left half of the orbicularis oris; 8', outer part of the same on the right side, the inner part being removed; 9, levator labii superioris; +, zygomaticus minor; 10, zygomaticus major; 11, depressor anguli oris; 12, depressor labii inferioris; d, cut ends of the levatores menti; 13, placed on the left masseter, points to the buccinator; 13′, buccinator of the right side, a portion of the parotid duct passing through the muscle; 14, levator anguli oris, seen also on the left side behind the zygomaticus minor; 15, sterno-mastoid, its sternal head, and 15′, its clavicular head; 16, sterno-hyoid; 17, posterior, 17′, anterior belly of the omo-hyoid, and 17″, portion of the deep fascia binding down its central tendon; 18, sterno-thyroid; 19, thyro-hyoid; 20, part of constrictors of pharynx; 22, trapezius; 25, levator scapulæ; 26, scalenus posticus; 27, scalenus medius; 28, scalenus anticus; 29, 29′, pectoralis major; 30, pectoralis minor.

many anatomists as only a deep origin of the palpebral part of the orbicularis muscle. It consists of a thin layer of fibres, which springs from the lachrymal crest behind the sac and, passing outwards and forwards, divides into two slips which are continued behind the lachrymal canals into the ciliary bundles of the orbicularis.

The **corrugator supercilii** is a small, deeply-coloured muscle, placed at the inner side of the eyebrow, under cover of the orbicularis and frontalis muscles. It arises from the inner extremity of the superciliary ridge of the frontal bone; thence its fibres proceed outwards and upwards, diverging somewhat, and end about the middle of the orbital arch, by passing between the bundles of the orbicularis and frontalis, and becoming inserted into the deep surface of the skin of the eyebrow.

*Relations.*—This muscle rests upon the frontal bone, and it crosses the supratrochlear branch of the ophthalmic nerve and the accompanying vessels, as they emerge from the orbit.

The **levator palpebræ superioris** lies in the upper part of the orbit. Its tendon only is seen in the dissection of the upper eyelid, in which it forms a broad expansion which curves downwards, and ends under cover of the orbicularis muscle and palpebral ligament by becoming blended with the fibrous tarsus. It will be fully described along with the muscles of the orbit (p. 281).

**Actions.**—The palpebral part of the *orbicularis* closes the eyelids, the upper lid ordinarily moving much more freely than the lower. The upper half of the orbital part depresses the eyebrow, and stretches the skin of the forehead, opposing the frontalis muscle; the lower half of this part raises the skin of the cheek, and gives rise to wrinkles below and outside the eye. The whole muscle comes into play in forcible closure of the eye, the orbital part then drawing up the surrounding skin and pressing the lids firmly together, while they at the same time are carried somewhat inwards towards the fixed part of the muscle. In closing the lids, as in winking, the contraction of the palpebral part of the orbicularis carries forwards the internal tarsal ligament and anterior wall of the lachrymal sac, which is thus dilated and sucks in the tears. The *tensor tarsi* muscle, according to one view, contracts simultaneously with the orbicularis, and draws backwards the puncta lachrymalia, disposing them more favourably for the admission of the tears; but it appears more probable that the tensor alternates in its action with the orbicularis, and that, by drawing backwards the tarsal ligament, it compresses the sac, and so propels the tears along the nasal duct into the nose. The *corrugator* muscle draws the skin of the outer part of the forehead downwards and inwards, producing longitudinal furrows at the inner end of the eyebrow, as in frowning. The upper eyelid is supported by the *levator palpebræ*, and droops when that muscle is paralysed. On the other hand, paralysis of the orbicularis is attended by an inability to close the eyelids.

## MUSCLES OF THE NOSE.

Under this head may be conveniently grouped not only the **compressor naris** and smaller muscles which act upon the nose alone, but also the **pyramidalis nasi** which acts on the forehead and the common **elevator of the lip and wing of the nose.**

The **pyramidalis nasi**, placed over the nasal bone, appears to be a prolongation of the inner part of the frontalis; its fibres, however, decussate with those of the latter muscle, and are attached to the skin at the lower and mesial part of the forehead. It widens slightly as it descends, and terminates in a tendinous expansion common to it and the compressor naris.

The **compressor naris**, a thin triangular muscle, arises narrow and fleshy from the facial surface of the superior maxillary bone by the side of the anterior nasal aperture; proceeding forwards and inwards it gradually expands into a thin aponeurosis, which is blended with that of the corresponding muscle of the opposite side, and with the pyramidalis nasi above, being closely attached to the skin of the nose, but only connected by loose areolar tissue to the subjacent cartilages. It is concealed at its origin by the muscle next described.

The **levator labii superioris alæque nasi**, the common elevator of the lip and nose, lies along the side of the nose, extending from the inner margin of the orbit to the upper lip. It arises by a pointed process from the nasal process of the superior maxillary bone, and, as it descends, separates into two fasciculi; one of these, much the smaller, is inserted into the wing of the nose, whilst the other is prolonged to the upper lip, where it is attached to the skin and becomes blended with the orbicularis and the special elevator muscle. It is subcutaneous, except at its origin, where the orbicularis palpebrarum overlaps it a little.

Fig. 195.

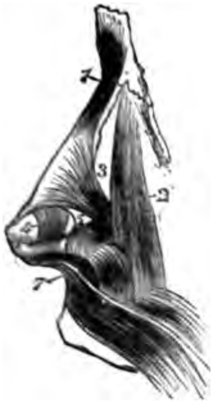


Fig. 195.—MUSCLES OF THE SIDE OF THE NOSE AND UPPER LIP. (A. T., after Arnold.) §

1, pyramidalis nasi; 2, levator labii superioris alæque nasi; 3, compressor naris; 4, levator proprius alæ nasi anterior; 5, levator proprius alæ nasi posterior; 6, depressor alæ nasi; 7, septal origin of orbicularis oris.

The **depressor alæ nasi** is a small flat muscle which arises from the incisor fossa of the superior maxilla, and is inserted into the septum and posterior part of the ala of the nose. Some fibres are continued from the outer part of this muscle into the compressor naris.

Besides the muscles above described there are other irregular and often indistinct fibres which enlarge the orifice of the nose. Of these the following may be distinguished.

The **levator proprius alæ nasi posterior**, or **dilatator naris posterior**, is attached to the lateral margin of the nasal aperture and the smaller (sesamoid) cartilages of the nose on the one hand, and to the skin on the other. Another set of fibres, the **levator proprius alæ nasi anterior**, or **dilatator naris anterior**, runs from the cartilage of the aperture of the nose to the skin at the margin of the nostril. The fibres of both of these muscles are very pale and often indistinct.

Varieties.—Absence of the pyramidalis has been observed. The compressor naris is sometimes very slightly developed, or even reduced to an aponeurotic condition. The dilators and depressor of the nostril are also subject to considerable variations in strength and in the mode of their attachment. The *musculus* *anomalus* of Albinus is a longitudinal muscular slip frequently present, lying beneath the common elevator of the lip and nose. It springs with the latter muscle from the nasal process of the superior maxilla, and ends below on the same bone in connection with the origin of the compressor naris.

**Actions.**—The *pyramidalis nasi* muscle takes its fixed point from below and draws down the integument of the forehead, producing wrinkles across the root of the nose. The *compressor naris*, acting along with its fellow of the other side, depresses the cartilaginous part of the nose, and to some extent also compresses the alæ together. The actions of the other muscles are sufficiently indicated by their names; the dilatation of the alæ is seldom perceptible in natural inspiration, but is well-marked in dyspnœa.

### MUSCLES OF THE LIPS AND MOUTH.

Around the orifice of the mouth is situated an orbicular muscle with concentric fibres, and this is joined by numerous other muscles which converge towards the aperture, viz., superiorly, the common elevator of the lip and nose already described, the proper elevator of the upper lip, the elevator of the angle of the mouth and the zygomatic muscles, laterally, the risorius and buccinator muscles, and inferiorly, the depressor of the angle of the mouth and that of the lower lip; and lastly, acting indirectly on the lower lip is the levator menti.

The **orbicularis oris** muscle, or **sphincter oris**, consists of labial and facial parts. The *labial* or *marginal* part occupies the red part of the lips, and forms a slightly convex fasciculus of pale fine fibres which are free from bony attachment, and can be traced from one lip to another round the corner of the mouth. The *facial* part, thinner and wider than the other, blends by its outer border with the several muscles that converge to the mouth, and receives fibres from them, especially from the buccinator, the fibres of which are continued into the deeper part of the orbicularis. Besides these fibres it has others that are attached to the subjacent cartilage and bone; viz., in the upper lip two bundles for each half; and in the lower lip one for each. In the upper lip the outer slip, thin and weak, passes downwards, and is attached to the incisor fossa of the upper jaw-bone below the depressor alæ nasi; while the other, thick and pointed, passes upwards and is fixed to the septum of the nose. In the lower lip the reinforcing fasciculus arises from the incisor fossa of the lower jaw external to the levator menti, and passing upwards and outwards towards the angle of the mouth, its fibres blend with the rest of the muscle.

*Relations.*—The skin of the lips is closely connected to the inner part of the orbicularis oris muscle, whilst over the outer part fatty tissue is interposed between them. The deep surface is in contact with the mucous membrane and the labial glands, as well as with the coronary arterial arch in each lip.

The **levator labii superioris proprius** muscle arises from the superior maxillary bone immediately above the infraorbital foramen, and from the adjoining surface of the malar bone; it passes downwards and a little inwards to be inserted into the skin of the upper lip and the orbicularis muscle.

*Relations.*—At its origin this muscle is overlapped by the orbicularis palpebrarum, but its greater part is subcutaneous; it partly conceals the levator anguli oris, and beneath it the infraorbital vessels and nerve emerge from the canal of the same name. Its inner border is generally united with the common elevator of the lip and nose.

The **levator anguli oris,** or **musculus caninus,** arises in the canine fossa immediately below the infraorbital foramen, inclines downwards and slightly outwards, and is inserted into the angle of the mouth, where it becomes blended with the fibres of the orbicularis, zygomaticus major and depressor anguli oris.

*Relations.*—At its origin this muscle is concealed by the proper elevator of the upper lip; its anterior surface supports the infraorbital nerve and artery, which separate it from the preceding muscle; the posterior surface lies on the superior maxilla and the buccinator muscle.

The ZYGOMATICI are two narrow and subcutaneous fasciculi of muscular fibres, extending obliquely from the most prominent part of the cheek towards the angle of the mouth, one being thicker and longer than the other.

The **zygomaticus minor,** a very small muscle, arises from the anterior and inferior part of the malar bone, and inclines downwards and forwards to terminate by joining the outer margin of the levator labii superioris; sometimes near the origin of that muscle.

The **zygomaticus major,** placed externally to the smaller muscle of the same name, arises from the malar bone near the zygomatic suture, from which it descends to the angle of the mouth, where it is partly inserted into the skin and partly continued into the orbicularis and depressor anguli oris.

*Varieties.*—The zygomaticus minor is frequently absent; or it may fall short of the mouth, and be inserted into the fascia of the cheek. It may arise wholly or in part from the orbicularis palpebrarum; it has also been observed fused with the zygomaticus major, or the levator labii superioris, or even united to the outer fibres of the frontalis (Eustachius). It has frequently been found double.

The zygomaticus major has also been found double, or it may be double merely at its insertion. Sometimes it arises from the masseteric fascia below the zygoma (Macalister). Absence of the muscle has also been observed.

The **risorius** (Santorini), or smiling muscle, is generally regarded as a part of the platysma myoides. It consists of some very thin fasciculi, which commence in the fascia over the masseter, or on the parotid gland, and, extending transversely inwards in the fat of the cheek, join the orbicularis and depressor anguli oris at the angle of the mouth.

*Varieties.*—The risorius is often absent. It has been seen to arise from the integument over the upper end of the sterno-mastoid (Hallet); from the zygoma (McWhinnie); from the external ear (Albinus); and from the fascia over the mastoid process (Macalister). It was found double and even triple by Santorini.

The lower and lateral part of the face receives a superficial muscular covering from the facial part of the **platysma myoides,** which is incorporated with the muscles of the angle of the mouth and lower lip, and passes along with the superficial fascia over the base of the jaw into the cervical portion of the muscle; the anterior portion of the cervical platysma, on the other hand, though continuous externally with the facial, takes firm attachment to the base of the jaw for a length of two inches or more external to the symphysis.

The **buccinator** muscle consists of a flat and thin but strong set of fibres in contact with the mucous membrane, and forming a considerable part of the wall of the mouth. It is attached by its upper and lower margins to the outer surface of the alveolar parts of the maxillary bones,

Fig. 196.

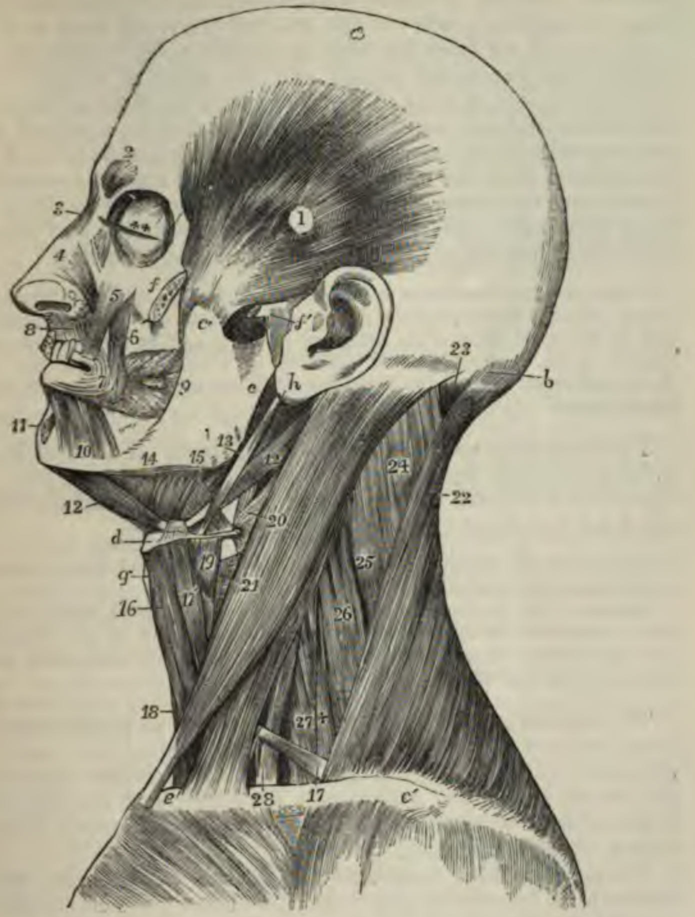


Fig. 196.—Deep muscles of the left side of the head and neck (modified from Bourgery). (A. T.) $\frac{1}{3}$

*a*, vertex of head ; *b*, superior curved line of occipital bone ; *c*, ramus of lower jaw ; *c'*, its coronoid process ; *d*, body of hyoid bone ; *e*, sternal end of clavicle ; *e'*, acromial end ; *f*, malar bone divided to show the insertion of the temporal muscle ; *f'*, divided zygoma, and external lateral ligament of the jaw ; *g*, thyroid cartilage ; *h*, placed on the lobe of the auricle, points to the styloid process ; 1, temporal muscle ; 2, corrugator supercilii ; 3, pyramidalis nasi ; 4, compressor naris ; 5, levator labii superioris ; 6, levator anguli oris ; 7, outer part of the orbicularis oris, the part below the nose has been removed ; 8, depressor alæ nasi ; 9, points to the buccinator muscle, through which the parotid duct is seen passing ; 10, depressor labii inferioris ; 11, levator menti ; 12, 12, anterior and posterior bellies of the digastric ; 13, stylo-hyoid muscle ; 14, mylo-hyoid ; 15, hyo-glossus, between which and 13, is seen a part of the stylo-glossus ; 16, sterno-hyoid ; 17, on the clavicle, indicates the posterior, and 17′, the anterior belly of the omo-hyoid ; 18, sterno-thyroid ; 19, thyro-hyoid ; 20, 21, on the sterno-mastoid muscle, point, the first to the middle, the second to the lower constrictor of the pharynx ; 22, trapezius ; 23, upper part of the complexus ; 24, 25, splenius ; 26, levator scapulæ ; 27, middle scalenus ; +, posterior scalenus ; 28, anterior scalenus.

opposite the molar teeth, and by its posterior margin to the *pterygo-maxillary ligament*, a narrow band of tendinous fibres, which extends from the hamular process of the internal pterygoid plate to the mylohyoid ridge of the lower jaw close to the last molar tooth, and is placed between the buccinator muscle and the superior constrictor of the pharynx (fig. 203, p. 297). From these parts the fibres of the muscle are directed forwards, approaching each other, so that the muscle is narrowed and proportionally thickened near the angle of the mouth, where it becomes incorporated with the orbicularis. The fibres near the middle of the muscle cross each other, those from above passing into the lower lip, and those from below into the upper one; but the higher and lower fibres are directed into the corresponding lip without decussation.

*Relations.*—The buccinator is covered and supported by a thin fascia, which is closely adherent to the muscular fibres; and is overlapped by the depressor anguli oris, by the upper fibres of the platysma myoides, and by the masseter and zygomaticus major, from which it is separated by a quantity of soft fat. Opposite the second molar tooth of the upper jaw, its fibres give passage to the duct of the parotid gland.

The **depressor anguli oris**, or **triangularis menti** muscle, is broad at its origin from the external oblique line of the lower jaw; passing upwards it is collected into a narrower bundle, which joins the orbicularis and other muscles at the angle of the mouth.

*Relations.*—This muscle is covered only by the skin and fat; it conceals part of the buccinator and of the depressor of the lower lip.

*Variety.*—The *transversus menti* (Santorini) is a small band of muscular fibres sometimes found arising from the inner border of the depressor, and curving downwards and inwards below the chin across the mesial line to the corresponding part of the opposite side.

The **depressor labii inferioris**, or **quadratus menti** muscle, arises from the lower jaw by a line of attachment extending from near the symphysis to a little beyond the mental foramen; thence it ascends with an inward inclination, unites with its fellow, and blending with the orbicularis oris is inserted into the lower lip. Its fibres are intermixed with much adipose matter.

The **levator labii inferioris**, or **levator menti** muscle, arises by a narrow head from the incisor fossa of the lower jaw, and expands as it is directed downwards and slightly forwards, between the depressors of the lower lip, to be inserted into the integument of the chin.

**Nerves.**—All the superficial muscles of the scalp and face previously described receive their motor fibres from one source, viz., the facial or seventh cranial nerve. The expression of the passions by the varying states of the skin of the forehead and eyebrows, the nostrils and mouth, the closure of the eyelids, the dilatation of the nostrils in breathing, and the movements of the lips in the prehension of food and otherwise, together with the movements of the scalp and external ear, when they are possible,—are all under the influence of this nerve, which was therefore considered by Sir Charles Bell to be a special nerve of respiration and expression.

**Actions.**—The *orbicularis oris* acting alone draws the lips together in both the vertical and transverse directions. Acting in conjunction with the buccinators it closes the lips, while at the same time they are elongated transversely. Its facial portion acting alone projects the lips. The labial portion, when acting in concert with the converging muscles, tightens the lips, one or both, against the teeth. The convergent muscles each draw their oral points of insertion in a direction corresponding to that of their muscular fibres. The *common elevator of the lip* *and nose* and the *depressor alæ nasi* act on the upper lip and the wing of the nose together—the one raising, the other depressing them. When the cheeks are distended with air, and the aperture of the lips narrowed, it is by the action of the *buccinator* that the forced expulsion of the air is regulated. The buccinator also flattens the cheek and keeps the food between the teeth during mastication. The *levator menti* draws upwards the integument of the chin and protrudes the lower lip, as in pouting. The muscles attached to the angles of the mouth are, along with others of the face, intimately connected with the expression of the passions: those which pass downwards not only raise the upper lip, but also push upwards the cheek, and thus elevate the margin of the lower eyelid, as in mirth; and those which ascend to the angle of the mouth depress that part, as in grief. (On the action of the facial muscles may be consulted, more especially, Sir Charles Bell, "Anatomy and Philosophy of Expression;" Duchenne, "Mécanismo de la Physionomie Humaine," Paris, 1862; and C. Darwin, "Expression of the Emotions in Man and Animals.")

### MUSCLES OF THE ORBIT.

In this group will be described seven muscles, namely, the elevator of the upper eyelid before referred to, and six muscles of the eyeball, viz., the four straight and the two oblique muscles. Of these muscles, the inferior oblique alone is confined to the fore part of the orbit; all the others take their origin at its back part, and pass forwards to their insertion.

The **levator palpebræ superioris** is a slender muscle which arises, pointed and tendinous, above and in front of the margin of the optic foramen, and, passing forwards over the eyeball, ends in a membranous expansion which is inserted into the fibrous tarsus of the upper eyelid.

*Relations.*—Between this muscle and the roof of the orbit are situated the fourth and frontal nerves and the supraorbital vessels, and beneath it are the superior rectus and the globe of the eye. On entering the lid, it is placed behind the palpebral ligament, and its deep surface rests on the conjunctiva.

The four STRAIGHT MUSCLES OF THE EYE have a continuous tendinous origin at the bottom of the orbit, in the form of an oval ring which, commencing above, passes down on the inner side to the lower margin of the optic foramen, then stretches transversely across the inner part of the sphenoidal fissure to be attached to its lower border, where a prominent bony point is generally developed, and finally is completed by again crossing the sphenoidal fissure, this time about the middle and vertically, to gain the upper edge of the optic foramen. The **superior rectus** springs from the part of this ring above or in front of the optic foramen, and beneath the levator palpebræ: the **internal rectus** arises on the inner side of and below the optic foramen: the **inferior rectus** springs mainly from a fibrous band occupying the inner part of the sphenoidal fissure; and the **external rectus** differs from the others in having two heads of origin, the lower and larger of which arises from the above-mentioned fibrous band and the prominent spine on the lower border of the sphenoidal fissure, being joined with the inferior rectus, while the upper is attached with the superior rectus between the sphenoidal fissure and the optic foramen; between the two bony origins fibres spring also from a tendinous arch over the fissure. The four recti thus attached posteriorly, pass forwards, one above, one below, and one on each side of the eyeball, becoming flattened as they lie in contact with it, and are inserted by short membranous and slightly expanded tendons into the fore part of the sclerotic coat, at a distance of from three to four lines from the margin of the cornea.

The external and inferior recti exceed the other two in length. On the other hand, the internal rectus is the broadest, and the superior the narrowest of all. At their insertions the internal is nearest to, and the superior is farthest from the edge of the cornea (Cruveilhier). Between the heads of the external rectus is a narrow interval which gives passage to the third and sixth nerves and the nasal branch of the fifth nerve, with the ophthalmic vein.

The **superior oblique** or **trochlearis** is a narrow elongated muscle, placed at the upper and inner part of the orbit, internally to the levator palpebræ. It arises about a line in front of the inner part of the optic foramen; thence it proceeds towards the front of the orbit, and terminates in a round tendon which passes through a fibro-cartilaginous ring or pulley (trochlea) attached to the trochlear fossa of the frontal bone; it is there reflected outwards, backwards and downwards, and passes between the eye and the superior rectus to be inserted into the sclerotic coat a little beyond the outer edge of that muscle, and midway between the cornea and the entrance of the optic nerve.

*Relations.*—This muscle is in contact with the roof of the orbit, the fourth nerve entering its upper surface; and beneath it lie the nasal nerve and the internal rectus muscle. The pulley is lined by a synovial sheath, and from its outer border an investment of firm connective tissue is prolonged on the tendon as far as the eyeball.

Fig. 197.

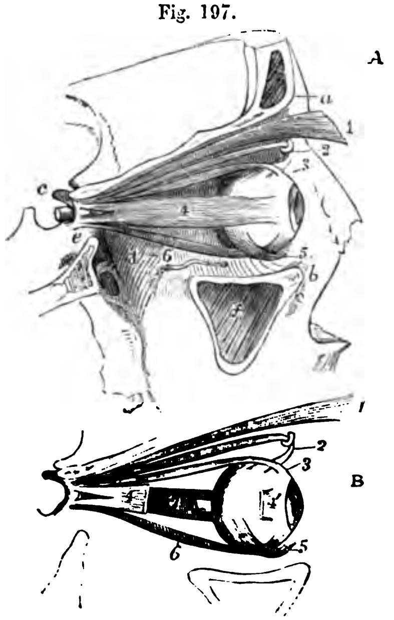


Fig. 197.—A VIEW OF THE MUSCLES OF THE RIGHT ORBIT, FROM THE OUTSIDE, THE OUTER WALL HAVING BEEN REMOVED. (A. T.) ½

B, EXPLANATORY SKETCH OF THE SAME MUSCLES.

*a*, orbital arch; *b*, lower margin of the orbit; *c*, anterior clinoid process; *d*, posterior part of the floor of the orbit above the spheno-maxillary fossa; *e*, side of the body of the sphenoid bone below the optic foramen and sphenoidal fissure; *f*, maxillary sinus; 1, levator palpebræ superioris, near its insertion; 2, pulley and tendon of the superior oblique muscle: 3, tendon of the superior rectus muscle at its insertion upon the eyeball; 4, in A, external rectus; 4′, in B, tendon of insertion of the same muscle, a large part of which has been removed; the double origin of the muscle is shown at the apex of the orbit; 5, inferior oblique muscle crossing the eyeball below the inferior rectus; 6, inferior rectus; 7, in B, the internal rectus, and near it, the end of the optic nerve cut short close to the place of its entrance into the eyeball.

The **inferior oblique** arises from a minute depression in the orbital plate of the superior maxillary bone, just within the anterior margin of the orbit, and close outside the orifice of the nasal duct. The muscle inclines outwards, backwards and upwards, passing between the inferior rectus and the floor of the orbit, and ends in a tendinous expansion which is inserted, under cover of the external rectus, into the eyeball at its posterior and outer part, and nearer to the optic nerve than the superior oblique.

*Varieties.*—The levator palpebræ sometimes gives off a slip from its inner border, which passes to be inserted into the trochlea, forming the *tensor trochleæ* of Budge. Absence of the levator palpebræ has been observed (Macalister).

The muscles of the eye seldom vary. The external rectus has been seen :—with its two heads separate to their insertion, thus forming a double muscle (Albinus); with absence of its outer (upper ?) head (Macalister); and giving slips to the outer wall of the orbit and the lower eyelid (Curnow).

The *transversus orbitæ* (Bochdalek) is an arched slip of muscular fibres passing from the orbital plate of the ethmoid across the upper surface of the eyeball to the outer wall of the orbit. It is probably, as Macalister suggests, a displaced deep slip of the palpebral fibres of the orbicularis.

**Nerves.**—Five of the muscles of the orbit, viz., levator palpebræ superioris, the superior, internal and inferior recti, and the inferior oblique, are under the influence of the third or common oculo-motor nerve; the external rectus is supplied by the sixth or abducent ocular, and the superior oblique by the fourth or trochlear nerve.

**Actions.**—The *levator palpebræ superioris* is simply an elevator of the upper eyelid, acting as the antagonist of the upper palpebral part of the orbicularis muscle.

The eyeball is so situated in the structures which surround it in the orbit that it is capable of free motion on a central fixed point; but it does not appear to shift its place as a whole within the orbit, at least to any extent, nor to undergo perceptible change of form from the action of the muscles. The position of the point round which the movements of the eyeball take place is nearly in the centre of curvature of the posterior wall, and from half a line to a line behind the middle of the antero-posterior axis of the eyeball.

The movements of the eyeball may be conveniently reduced to four kinds, viz., 1, simple lateral movements in a horizontal plane; 2, simple movements of elevation or depression; 3, oblique movements of elevation or depression; and 4, movements of rotation. In the first two kinds the vertical meridian of the eye is not subject to any change of inclination; in the third kind the movements of direction are accompanied by a small amount of inclination of the vertical meridian to one or other side; and in the fourth kind, when simple, the whole movement is one of inclination of the vertical meridian. These movements, however, unless perhaps the first, are seldom simple, but more frequently different kinds are combined together. The three first kinds constitute the various movements of direction by which the visual axis is turned within certain limits to various points in space; the extent of motion being about 90° in the vertical and 100° in the horizontal direction. Simple movements of rotation do not appear to occur to any considerable extent, and it has been ascertained by experiment that they are not sufficient, as was supposed by Hueck and others, to maintain the eyeballs in a fixed position during inclined movements of the head.

In these different movements the six muscles of the eyeball may advantageously be considered as acting in three pairs. 1st. In the horizontal movements the *internal* and *external recti* muscles are the sole agents, the one acting as an adductor and the other as an abductor; and this movement they effect without any rotation, their line of action being exactly in the horizontal plane of the eyeball. 2nd. It is different with the *superior* and *inferior recti;* for while these muscles undoubtedly are respectively the most direct elevators and depressors of the cornea, they have both a tendency, from the line of their action being to the inner side of the centre of motion of the eyeball, to produce inward direction with a small amount of rotation. This tendency is corrected by the association of the *oblique* muscles in all upward and downward movements; the inferior oblique being associated with the superior, and the superior oblique with the inferior rectus muscle. The simple action of the superior oblique muscle, when the eye is directed straight forward, is to produce a movement of the cornea downwards and outwards, that of the inferior oblique to direct the cornea upwards and outwards, and in both with a certain amount of rotation, though in different directions in the two cases. But these movements caused by the oblique muscles are precisely those which are required to neutralise the inward direction and rotatory movements produced by the superior or the inferior rectus, and accordingly, by the combined action of the superior rectus and the inferior oblique muscles a straight upward movement is effected, while a similar effect in the downward direction results from the combined action of the inferior rectus and superior oblique muscles.

It has been further shown that in all the oblique movements of direction a combination takes place of the action of the oblique with that of the straight muscles. Here, however, two recti muscles are in action and are associated with one oblique muscle; as, for example, in the upward and inward direction, the superior and internal recti with the inferior oblique; and in the downward and inward direction the inferior and internal recti with the superior oblique. And the same is true of the upward and outward and downward and outward movements of direction; for in all these movements the action of the oblique muscles is necessary to control or supplement the rotatory tendency of the recti muscles; and in the consentaneous movements of the two eyes the whole six muscles must co-operate in both eyes to produce that perfect agreement in their movements of direction and convergence which is required for perfect vision.

It is unnecessary here to enter into the detail of the modifications of these actions of the muscles which must accompany changes in the various consentaneous movements of the eyes, as, for example, in the convergence which is associated with the adjustment of the eyes to near and distant vision. (Consult M. Foster, "Text-book of Physiology"; Donders, "On the anomalies of Accommodation," &c. Syd. Soc. 1864; Helmholtz, Proc. Roy. Soc. xiii. 186, and "Physiological Optics," and Hering in Hermann's "Handbuch der Physiologie," Bd. iii.)

**Fasciæ of the orbit.**—The space within the orbit which is not occupied by the eyeball and its muscles, or other parts belonging to it, is completely filled with soft fat and delicate yielding connective tissue. In various places this last is condensed into layers of slender fascia of various degrees of strength, the principal of which is that known as the *fascia* or *capsule of Tenon*, a thin membrane surrounding the greater part of the eyeball, and forming the wall of a socket in which the globe plays. The fascia is perforated behind by the optic nerve and ciliary vessels and nerves, there becoming continuous with the connective tissue investing those structures, and in front it extends nearly as far as the cornea, where it ends by being attached to the ocular conjunctiva. Its inner surface is connected to the sclerotic coat of the eye only by delicate bundles of yielding connective tissue, the two being separated for the most part by an extensive lymph-space, so that it seems to serve all the purposes of a synovial membrane in the movements of the globe. The fascia is also pierced by the muscles of the eyeball near their insertions, and it sends a tubular prolongation on each of these, which speedily degenerates, however, into a simple areolar investment, except in the case of the sheath on the tendon of the superior oblique, which is stronger than the others and is continued as far as the pulley. The sheaths of the recti adhere closely to the muscular substance, and from their outer part expansions are given off to the margin of the orbit, which serve to limit the degree of contraction of the muscles. The processes from the sheaths of the inner and outer recti are stronger than the other two, especially the external, which is attached to the malar bone and external tarsal ligament. The inner expansion is fixed to the crest of the lachrymal bone; and the upper one is connected also with the tendon of the levator palpebræ, so that the superior rectus is thus enabled to exercise some influence upon the upper eyelid (Sappey, "Traité d'Anatom. descrip." t. ii.; v. Gerlach, "Beiträge zur norm. Anat. des menschl. Auges," Leipzig, 1880.)

Certain collections of involuntary muscular fibres that are contained in the eyelids and wall of the orbit will be noticed in connection with the anatomy of the eye in Vol. II.

## MUSCLES OF MASTICATION.

The masseter, temporal, and two pterygoid muscles form a group of
scles of mastication, which may be properly considered together.

The **masseteric fascia** is a continuation upwards of the deep fascia
the neck over the masseter muscle. It is firmly bound down to the
ter surface of the muscle, and is attached superiorly to the zygoma.
rther back the fascia invests closely the parotid gland (*parotid fascia*),
the posterior and deep surfaces of which a process is also sent
wards; a strong band of this process, the *stylo-maxillary ligament*,
tending from the angle of the jaw to the styloid process, separates the
rotid and submaxillary glands.

The **masseter** (fig. 194, 13) is a thick quadrate muscle, the fibres of
ich form two portions differing in size and direction. The *superficial*
rt, obliquely foursided in form, arises from the lower border of the zygo-
atic arch for the anterior two-thirds, chiefly by thick tendinous bundles
ojecting down between the muscular fasciculi, to which they afford an
tensive surface of origin: its fibres proceed downwards and back-
rds to be inserted into the lower half of the ramus of the jaw, extend-
g as far as the angle. The *deep* part of the muscle, of a triangular
rm, consists of fibres which are much shorter than those of the super-
ial part, and are directed nearly vertically downwards. They arise
m the posterior third of the lower border and from all the deep sur-
ce of the zygomatic arch, and, becoming united with the superficial
rt, are inserted into the upper half of the ramus of the jaw, including
e coronoid process: only the upper and back part of this portion of
e muscle is left uncovered by the superficial portion.

*Relations.*—The external surface of the masseter muscle is covered for the most
rt only by the skin and fascia, together with, in the lower half, the platysma
oides; it is, however, overlapped behind by the parotid gland, and crossed by
duct; some branches of the facial nerve and the transverse facial artery also
t upon it. The fore part of its inner surface is towards the buccinator, from
ich it is separated by soft adipose tissue; the greater part is in close contact
th the ramus of the jaw, and covers a nerve and vessels which enter it through
sigmoid notch of that bone.

The **temporal fascia** is a dense white shining aponeurosis, which
vers the temporal muscle above the zygoma, and gives attachment to
ne of its fibres of origin. It is attached superiorly to the temporal
st of the frontal bone and to the upper of the two lines on the
rietal bone; while inferiorly it is divided into two layers which are
parated by a small quantity of fat, and are attached respectively to
e inner and outer surfaces of the zygomatic arch close to its upper
rder. This dense fascia is separated from the integuments by the
er of thin membrane descending from the epicranial aponeurosis, and
the auricular muscles; and from the temporal muscle, at the lower
rt, by a layer of fat.

The **temporal** muscle (fig. 196, 1) is fan-shaped, and arises from the
ole surface of the temporal fossa, with the exception of the anterior or
lar wall, and from the deep surface of the temporal fascia, except close
the zygomatic arch; some of its posterior fibres arising from this fascia
end with the deep fibres of the masseter muscle. The direction of the
terior fibres is nearly vertical, that of the middle fibres oblique, and
at of the posterior fibres at first almost horizontal. The fibres converge

as they descend, and terminate mostly in a tendon, which is implanted into the upper and anterior borders of the coronoid process of the lower jaw, while the deeper fibres have a fleshy insertion into the inner side of the process, reaching down to the union of the ramus and body of the jaw.

*Relations.*—The upper part of the muscle is closely covered by the temporal fascia; the lower and anterior part is imbedded in fat continuous with that which lies between the masseter and buccinator muscles. Between the muscle and the bone of the temporal fossa are the deep temporal arteries and nerves, which penetrate its substance. In contact with the deep surface of the muscle near its insertion the buccal nerve descends, and at the posterior border of the insertion the masseteric nerve and artery emerge.

The **internal pterygoid** muscle arises from the pterygoid fossa, its fibres, tendinous and fleshy, being attached mostly to the inner surface of the external pterygoid plate, and that portion of the tuberosity of the palate bone which is situated between the pterygoid plates, and by a second smaller slip, lying outside the external pterygoid muscle, from the outer surface of the tuberosities of the palate and superior maxillary bones. Thence it is inclined downwards, with a direction backwards and outwards, and is inserted into the rough mark on the inner side of the ramus of the jaw between the angle and the dental foramen.

*Relations.*—The internal pterygoid muscle is placed on the inner side of the ramus of the jaw, somewhat in the same manner as the masseter lies on the outside. Between the external surface of the muscle and the ramus of the maxilla are the internal lateral ligament and the internal maxillary vessels, with the dental artery and nerve; and at its upper part the larger head is crossed by the external pterygoid muscle. Its inner surface is in contact with the tensor palati muscle, and with the superior constrictor of the pharynx.

Fig. 198.

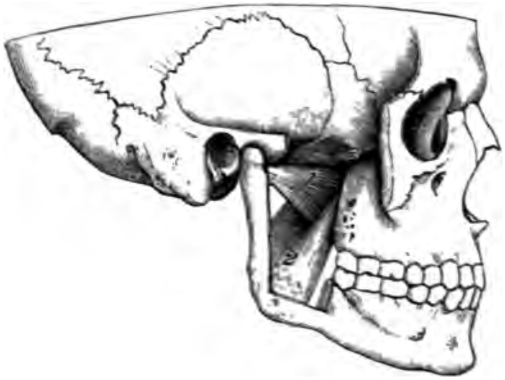


Fig. 198.—The pterygoid muscles from outside. ½

The masseter muscle, the greater portion of the zygomatic arch, the temporal muscle with the coronoid process, and a large part of the ramus of the jaw have been removed. 1, external pterygoid: the figure is placed on the lower head; 2, internal pterygoid.

The **external pterygoid** muscle, occupying the zygomatic fossa, arises by two fleshy heads placed close together, the superior of which is attached to the zygomatic surface of the great wing of the sphenoid, and to the infratemporal crest which separates that surface from the temporal fossa; while the inferior, which is larger, is attached to the outer surface of the external pterygoid plate. The fibres from both heads pass backwards, and converge to be inserted into the depression on the front of the neck of the lower jaw, and into the interarticular fibro-cartilage of the temporo-maxillary articulation.

*Relations.*—The internal maxillary artery is usually placed on the outer surface of this muscle, passing thence between the heads of origin; while the buccal nerve issues from between those heads. The deep surface rests against the upper part of the internal pterygoid muscle, the direction of which it crosses, also the internal lateral ligament of the lower jaw, the inferior maxillary nerve, and the middle meningeal artery. The upper border is crossed by the deep temporal and masseteric nerves.

*Varieties.*—The *pterygoideus proprius* (Henle) is a nearly vertical band of muscular and tendinous fibres, sometimes entirely tendinous, passing from the infratemporal crest of the great wing of the sphenoid, over the surface of the external pterygoid muscle, to the lower part of the outer pterygoid plate, or to the tuberosity of the palate or superior maxillary bone. It has been seen sending a slip to the pterygo-maxillary ligament, or even to the lower jaw.

*Pterygo-spinosus* (G.D.T.)—This name may be given to a muscular slip occasionally seen, springing from the spine of the sphenoid, and inserted into the hinder margin of the outer pterygoid plate, between the external and internal pterygoid muscles. A fibrous band connecting these parts (*pterygo-spinous ligament*) is frequently present, and is sometimes converted into bone (*cf.* p. 45).

Fig. 199.

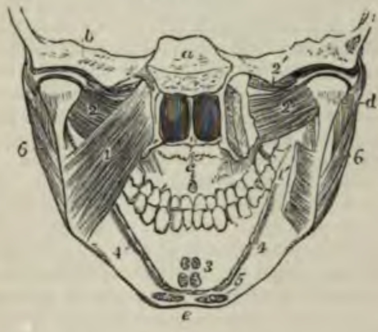


Fig. 199.—VIEW OF THE LOWER PART OF THE SKULL AND FACE, FROM BEHIND, TO SHOW THE ATTACHMENTS OF THE PTERYGOID AND SOME OTHER MUSCLES (modified from Bourgery). (A. T.) $\frac{1}{3}$

*a*, body of the sphenoid, below which are seen the posterior nares; *b*, section through the temporal bone; *c*, hard palate; *d*, back of the head and neck of the lower jaw, above which are seen the synovial cavities of the joint separated by the interarticular fibro-cartilage; *e*, placed below the symphysis menti; 1, on the left internal pterygoid muscle; 1′, on the right side, the lower part of the same muscle, of which the middle portion has been removed to show the external pterygoid; 2, the lower head of the external pterygoid; 2′, on the right side points to the upper head of the muscle, attached in part to the interarticular disc; 3, small portions of the genio-hyoid and genio-glossus muscles cut short at their attachment to the mental spines; 4, the attachment of the mylo-hyoid cut short; 5, the attachment of the anterior belly of the digastric; 6, 6, masseter muscles.

**Nerves.**—The four muscles above described receive their nerves from the muscular branches of the inferior maxillary which may be traced to the small or motor root of the fifth nerve. These nerves are named from the muscles they respectively supply. There are two or three branches to the temporal, and one to each of the other muscles.

**Actions.**—The masseter, temporal and internal pterygoid muscles are elevators of the lower jaw, and generally act in concert, bringing the lower teeth forcibly into contact with the upper. The opposite movement of depressing the jaw, not being opposed by any resisting obstacle, requires less force, and is effected by muscles of much smaller size, the principal of which is the digastric muscle hereafter described. The external pterygoid muscle, having the great body of its fibres nearly horizontal, draws forwards the condyle of the jaw, and, when the muscles of both sides act together, the lower jaw is protruded so as to make the lower incisor teeth project beyond the upper; but their more usual mode of action is alternately on the two sides, as in the grinding movement of the molar teeth, in which the horizontal movements of the external pterygoids are associated with the elevating actions of the other muscles. The hinder portion of the temporal muscle retracts the jaw, and is thus the antagonist of the external pterygoid.

### SUBCUTANEOUS MUSCLE OF THE NECK.

**The platysma myoides** (fig. 193, 14) is a pale-coloured thin sheet of muscular fibres, superficial to the deep cervical fascia, and extending over the front and side of the neck and lower portion of the side of the face. Its fibres rise by thin bands from the subcutaneous tissue over the upper part of the deltoid, pectoral, and trapezius muscles; thence they proceed upwards and inwards over the clavicle and the side of the neck, gradually converging and approaching the muscle of the opposite side. The greater number of the fibres are inserted into the outer surface of the lower jaw from the mental prominence to the attachment of the masseter; some of the inner fibres mingle with those of the opposite platysma in front of the symphysis, and the innermost fibres of all cross from the one side to the other below the chin, those of the right side being generally superficial, and are attached to the lower border of the jaw opposite the mental prominence; the posterior fibres are prolonged upon the side of the face as far as the angle of the mouth, blending with the depressor anguli oris and orbicularis muscles.

*Varieties.*—The muscular fibres of the platysma sometimes extend upwards on the face and downwards on the neck, shoulder and breast farther than usual; and they occasionally take attachment to the clavicle. The upper part of the muscle is occasionally joined by a slip from the mastoid process, or from the occipital bone, and the frequently occurring muscular fasciculus known as the *occipitalis minor*, springing from the fascia over the upper end of the trapezius, and ending similarly over the insertion of the sterno-mastoid, is probably a less developed form of this accessory slip of the platysma. Suppression of the platysma on one or both sides is recorded by Macalister. This muscle is the representative in man of a subcutaneous group of muscles, the *panniculus carnosus*, largely developed in most mammals, by which very varied movements of the skin and some superficial parts may be effected, as, for example, when the horse communicates a rapid motion to the skin to free itself from insects, or the dog shakes off the water after swimming, or the hedgehog elevates its spines.

**Nerves.**—The platysma receives its principal motor nerves from the descending branches of the facial, but as this unites with the superficial cervical nerve it may also be influenced through some of the spinal nerves.

**Action**.—The platysma raises the skin of the breast and shoulder and draws the angle of the mouth forcibly downwards and outwards: at the same time it carries the skin of the neck forwards, reducing the angle between the chin and neck. The muscle is put into action in swallowing, and is also called into play in expressing sudden terror.

### MUSCLES AND FASCIÆ OF THE NECK ANTERIORLY.

Fasciæ.—The **deep cervical fascia** passes forwards from the upper border of the trapezius muscle over the side and front of the neck beneath the platysma myoides. Posteriorly it is continuous with the layers of areolar tissue by which the trapezius and deeper muscles are invested, and it extends over the posterior triangle of the neck. [illegible] the space bounded by the trapezius and sterno-mastoid muscles and the clavicle. At the posterior border of the sterno-mastoid it divides into two layers, which form an investment for that muscle; these unite again at the anterior border into a membrane which passes forwards to the middle line, where it becomes continuous with the fascia of the opposite side, and covers the area bounded by the middle line, the lower border of the jaw, and the sterno-mastoid muscle, and called he anterior triangle. In the posterior triangle the fascia is attached nferiorly to the clavicle, and near that bone is perforated by the xternal jugular vein, which in the previous part of its course lies on the urface of the membrane. In the anterior triangle it is bound superiorly o the base of the jaw in front, and farther back is continued supericially over the parotid gland (*parotid fascia*) to the zygoma, sending pwards also a deep process between the submaxillary and parotid lands, in which the stylo-maxillary ligament is developed.

Anteriorly the fascia is attached to the hyoid bone, and becoming tronger as it descends, it splits, a little below the level of the thyroid ody, into two distinct layers. Of these the more superficial and weaker, unning along the sterno-mastoid muscles, is fixed to the sternum and he interclavicular ligament; whilst the stronger layer, lying under the ormer, and closely covering the sterno-hyoid and sterno-thyroid uscles, is attached to the deeper surface of that bone. Between these ayers, at the upper border of the sternum, is a small space which xtends also a short distance on each side above the clavicle and behind he sternal head of the sterno-mastoid. This space contains some loose onnective tissue and fat, and sometimes a small lymphatic gland, and n the lateral recess the anterior jugular vein is directed outwards.

Prolonged from the deeper of these two layers, a fascia is found n the posterior triangle, investing the posterior belly of the omo-hyoid uscle, and binding it down to the clavicle and first rib, where this tructure is connected with the costo-coracoid membrane. Still deeper n the anterior triangle a process of the fascia passes behind the depressor uscles of the hyoid bone, investing the thyroid body, and extending hence on the trachea and large vessels at the root of the neck down to he fibrous layer of the pericardium.

Continuous with the deep processes of the cervical fascia is the *carotid heath*, an envelope of fascia enclosing the carotid artery and jugular vein with the pneumo-gastric nerve. A thin fibrous septum intervenes etween the artery and vein, thus completing a separate sheath for each.

Lastly, the *prevertebral fascia* is a layer descending on the prevertebral muscles, and separating them from the pharynx and œsophagus. Laterally his becomes continuous with, or forms, the back of the carotid sheath, nd is then prolonged outwards and downwards over the scaleni muscles, he brachial plexus of nerves and the subclavian vessels, which it accompanies into the upper part of the axilla, thus giving rise to the *axillary heath*.

MUSCLES.—Immediately beneath the fascia is a large oblique muscle, xtending the whole length of the neck, and named from its attachments he sterno-cleido-mastoid. At a deeper level than this are two sets of muscles situated respectively above and below the hyoid bone. The muscles of the upper set are known as the suprahyoid muscles or elevators f the hyoid bone; those of the lower set are the infrahyoid muscles or epressors of the hyoid bone.

The **sterno-cleido-mastoid** or **sterno-mastoid** muscle is attached inferiorly in two parts to the anterior surface of the manubrium and to the inner third of the clavicle on its upper aspect. The sternal head is thick and rounded, tendinous in front and fleshy behind. The clavicular portion, eparated from the sternal by a narrow interval, is flat, and is composed of fleshy and tendinous fibres. The two portions meet and form a thick prominent muscle, which, extending upwards and backwards, is inserted [illegible] by short tendinous fibres into the anterior border and external surface of the mastoid process, as well as into a rough ridge continued backwards from that, and by a thin aponeurosis into the outer half or more of the superior curved line of the occipital bone. The sterno-mastoid muscle divides the quadrilateral space on the side of the neck into two great triangles.

*Relations.*—This muscle is covered for more than the middle three-fifths of its extent by the platysma. It is also crossed by the external jugular vein, and by the great auricular and superficial cervical nerves. It rests below on part of the sterno-hyoid and sterno-thyroid muscles, and crosses the omo-hyoid: in the middle part of the neck it covers the cervical plexus and the great cervical vessels, and in the upper part, the splenius and digastric muscles. It is pierced by the spinal accessory nerve.

*Varieties.*—This muscle consists of two parts, *sterno-mastoid* and *cleido-mastoid*, which are sometimes described as separate muscles. The cleido-mastoid, the smaller of the two, runs upwards nearly vertically under the sterno-mastoid, and is inserted separately by a rounded tendon into the tip of the mastoid process: this part is pierced by the spinal accessory nerve. In many cases (37 times in 102 subjects, Wood) a third factor is added, a *cleido-occipitalis*, which arises from the clavicle in front of or outside the cleido-mastoid and applies itself to the hinder border of the sterno-mastoid, being inserted in continuation of that along the superior curved line. The clavicular origin of the muscle varies greatly in width, being sometimes as narrow as the sternal, while in other instances it extends for three inches along the bone: in such cases it may be divided into separate slips. In animals without a clavicle the cleido-mastoid is continued into the clavicular part of the great pectoral muscle or deltoid, thus forming a cephalo-humeral muscle.

*Transversus nuchæ.*—This name is given by Schulze to a fasciculus of frequent occurrence springing from the external occipital protuberance in connection with the upper end of the trapezius, and inserted into the aponeurosis of the sterno-mastoid. When absent, tendinous fibres run in its place.

*Supraclavicularis* (Luschka).—This is a small muscle not unfrequently met with, lying behind the origin of the sterno-mastoid. It arises by a slender tendon from the upper border of the manubrium, passes upwards and outwards above the sterno-clavicular articulation, and is inserted into the upper surface of the clavicle. When present on both sides the two muscles may be joined in the middle line.

**Nerves.** The sterno-mastoid receives its principal nervous supply from the spinal accessory, the filaments of which to the muscle are joined by a branch of the second cervical nerve.

## INFRAHYOID MUSCLES.

The **sterno-hyoid** muscle, a thin band of longitudinal fibres, arises variably from [illegible] of the sternum and the posterior sterno-clavicular ligament, [illegible] from the clavicle only, and sometimes [illegible] of the first rib. It is inserted [illegible] of the body of the hyoid bone.

[illegible] is covered below by the sternum and the sterno-mastoid [illegible] in the sterno-thyroid [illegible] The inner border approaches [illegible] but is separated [illegible] near the sternum: [illegible] near the hyoid bone.

[illegible] met with, or more [illegible] from the clavicle, and inserted [illegible]. Absence of the sterno-hyoid on e side has been seen (G. D. T.). The muscular fibres are occasionally interrupted a transverse tendinous intersection at the level of the intermediate tendon of e omo-hyoid, or in rare cases opposite the insertion of the sterno-thyroid.

The **sterno-thyroid**, broader and shorter than the preceding muscle, behind which it lies, arises from the thoracic surface of the first piece of the sternum, lower down and more internally than the sterno-hyoid, and variably from the first and second rib-cartilages; it ascends, diverging a little from its fellow, and is inserted into the oblique line on the ala of the thyroid cartilage.

Fig. 200.

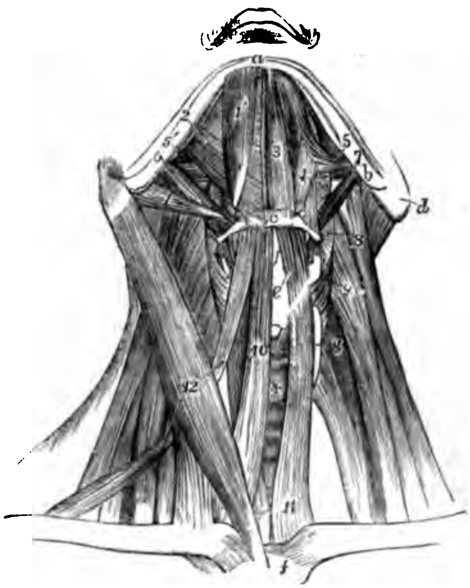


Fig. 200.—Muscles of the neck, from before. (A. T.) ½

On the right side, the platysma alone has been removed; on the left side, both bellies of the digastric, the stylo-hyoid, mylo-hyoid, the sterno-hyoid and omo-hyoid muscles have been removed: *a*, symphysis, *b*, angle of the lower jaw; *c*, body of the hyoid bone; *d*, mastoid process; *e*, placed on the front of the thyroid cartilage, points to the thyro-hyoid muscle; *f*, upper part of the sternum; *g*, lateral lobe, and +, isthmus of the thyroid body; above +, the front of the cricoid cartilage and the crico-thyroid muscle; 1, posterior, and 1', anterior belly of right digastric muscle; 2, right mylo-hyoid; 3, left genio-hyoid; 4, hyo-glossus; 5, stylo-glossus; 5', a portion of it seen on the right side; 6, stylo-hyoid of the right side; 7, stylo-pharyngeus of the left side; 8, placed on the levator scapulæ, points to the left middle constrictor of the pharynx: 9, placed on the middle scalenus, points to the left inferior constrictor; 10, right sterno-hyoid; 11, placed on the left sterno-thyroid, points also to the lower part of the right muscle; 12, placed on the right sterno-mastoid, points to the anterior and posterior bellies of the right omo-hyoid.

*Relations.*—The greater part of its anterior surface is concealed by the sternum and the sterno-hyoid muscle, as well as by the sterno-mastoid. By its deep surface it rests on the innominate vein, the lower part of the common carotid artery, the trachea, and the thyroid body. The inner margin is contiguous to the muscle of the other side in the lower part of the neck.

*Varieties.*—The two sterno-thyroid muscles are frequently united across the middle line at their origins. Absence of the muscle has been observed (Macalister), also doubling. It is occasionally partly crossed by transverse or oblique tendinous lines. At the upper extremity a few fibres are often continued into the thyro-hyoid muscle or into the inferior constrictor of the pharynx. From the outer border a slip is occasionally given off to the sheath of the carotid vessels, covering them as high as the thyroid cartilage (*costo-fascialis*, Wood).

The **thyro-hyoid** muscle forms a continuation upwards of the preceding; it arises from the oblique line on the ala of the thyroid cartilage, and is inserted into the lower border of the body and great cornu of the hyoid bone.

*Relations.*—This muscle is concealed in great part by the sterno-hyoid and omo-hyoid; it rests on the ala of the thyroid cartilage, and on the thyro-hyoid membrane. Between that membrane and the muscle, the superior laryngeal nerve and artery are placed before entering the larynx.

The **omo-hyoid** is a long ribbon-shaped muscle, consisting of two bellies united by an intervening tendon. It arises from the upper border of the scapula, near the suprascapular notch, and occasionally from the ligament which crosses the notch. Thence it extends forwards and only slightly upwards, across the root of the neck, till it passes beneath the sterno-mastoid muscle, and then, curving rapidly, it ascends nearly vertically, to be inserted into the lower border of the body of the hyoid bone immediately outside the sterno-hyoid. The tendon which divides the muscle is placed beneath the sterno-mastoid muscle, and varies much in length and form in different bodies. The tendon is enclosed within the deep cervical fascia, which, after forming a sort of sheath for it, is prolonged downwards, and becomes attached to the sternum and the cartilage of the first rib; and by this means, as also by fascia investing the posterior belly and descending to the clavicle, the muscle is maintained in its bent position.

*Relations.*—At its scapular origin the muscle is covered by the trapezius, in the middle of its course by the sterno-mastoid; the two bellies appear one in each of the triangles of the neck, the anterior crossing the common carotid artery, the posterior bounding the small triangle in which the subclavian artery is found; it also lies over the scaleni muscles, the lower cervical nerves, the sheath of the common carotid artery and jugular vein, and the sterno-thyroid and thyro-hyoid muscles.

*Varieties.*—These are very frequent. The commonest is an attachment to the clavicle, which may be the sole origin of the posterior belly, or it may be by a supernumerary belly. Complete doubling of the muscle has been observed in a few cases. On the other hand entire absence on both sides is recorded; also absence of the anterior belly, its place being taken by a band of fascia. The anterior belly is sometimes fused with the sterno-hyoid.

**Nerves.**—The infrahyoid muscles receive their motor nerves mainly from the hypoglossal, the thyro-hyoid by a direct branch from the trunk of the nerve, the rest from the descending branch in combination with the communicating branches from the second and third cervical nerves.

### SUPRAHYOID MUSCLES.

The **digastric** muscle consists of two elongated fleshy bellies united by an intervening rounded tendon. The posterior belly arises from the digastric fossa of the temporal bone, and is directed downwards, forwards and inwards, tapering gradually, towards the hyoid bone: the anterior is attached to a rough depression on the lower border of the lower jaw, close to the symphysis menti; it is shorter and broader than the posterior belly, and is directed downwards, backwards, and slightly outwards. The intervening tendon is connected to the body and great cornu of the hyoid bone by a broad band of aponeurotic fibres and by the fleshy fibres of the stylo-hyoid muscle, through which the tendon passes.

*Relations.*—The posterior belly is for the most part concealed by the mastoid process, the sterno-mastoid and splenius muscles, and the parotid gland; it crosses the internal and external carotid arteries, with the internal jugular vein and accompanying nerves. The anterior belly is placed immediately beneath the deep cervical fascia, and rests on the mylo-hyoid muscle; its inner border is connected by a dense aponeurosis with its fellow of the opposite side.

*Varieties.*—The digastric muscle is subject to many variations. The posterior belly has been seen receiving an accessory slip from the styloid process (Wood), or arising entirely from that part, or connected by a slip with the middle or inferior constrictor of the pharynx (Perrin, Curnow). The anterior belly has been joined by a slip arising from the lower jaw in front of the angle (Henle). In rare cases the muscle is monogastric, the anterior attachment in that case taking place about the middle of the body of the lower jaw (McWhinnie). The anterior belly is frequently divided into two or more parts, one or even two of which may cross the middle line and decussate with similar slips from the muscle of the opposite side; or a slip sometimes passes to the median raphé of the mylo-hyoid, or becomes incorporated with its fellow of the opposite side. Its deep surface is sometimes united by muscular fibres with the subjacent mylo-hyoid. The tendon of the digastric has been seen in front of, or more rarely behind the stylo-hyoid, instead of passing through it.

The *mento-hyoid* (Macalister) is an occasional mesial slip found passing from the body of the hyoid bone to the chin. It sometimes consists of two parallel bands, and Macalister suggests that it may be a differentiated portion of the platysma.

The **stylo-hyoid** is a slender muscle placed along the upper border of the posterior belly of the digastric. It arises by a narrow tendon from the back of the styloid process of the temporal bone near the root, and inclines downwards and forwards, to be inserted into the hyoid bone at the union of the great cornu with the body. Its fibres are usually divided into two fasciculi near its insertion, for the transmission of the tendon of the digastric muscle.

*Relations.*—The upper part of the stylo-hyoid is covered by the parotid gland; the lower part is superficial. The muscle crosses the external carotid artery. The lower part of the stylo-hyoid, the anterior belly of the digastric, and the base of the lower jaw bound a triangular space which contains the submaxillary gland, and is known as the submaxillary triangle.

*Varieties.*—The stylo-hyoid is not unfrequently wanting, while, on the other hand, doubling of the muscle has also been recorded. It is occasionally placed on the inner side of the external carotid artery. The insertion may take place partly or wholly into the tendon of the digastric; or fibres are continued into the omo-hyoid, thyro-hyoid, or mylo-hyoid muscles. An additional muscular slip is occasionally seen (*stylo-hyoideus alter*—Alb.), passing from the styloid process to the small cornu of the hyoid bone, and accompanying or replacing the stylo-hyoid ligament.

The **mylo-hyoid** muscle arises from the mylo-hyoid ridge on the inner surface of the lower jaw, extending from the last molar tooth to the symphysis. The nearly parallel fibres pass inwards, backwards and downwards; the hinder ones are inserted, shortly tendinous, into the body of the hyoid bone, while the larger number, becoming gradually shorter as they are placed farther forwards, meet at an angle with those of the opposite muscle and end in a median tendinous raphé, extending from the symphysis of the jaw to the hyoid bone. Thus the two muscles together form a floor below the anterior part of the mouth (*diaphragma oris*, Meyer).

*Relations.*—The lower surface of the mylo-hyoid is in contact with the anterior belly of the digastric, the submaxillary gland, the facial artery and its submental branch, and the mylo-hyoid vessels and nerve. The muscle covers the genio-hyoid, genio-glossus, and parts of the hyo-glossus and stylo-glossus muscles, the sublingual gland and the duct of the submaxillary gland, and the lingual branch of the fifth and the twelfth nerves. The posterior border alone is free, and around it the deep part of the submaxillary gland turns.

Fig. 201.

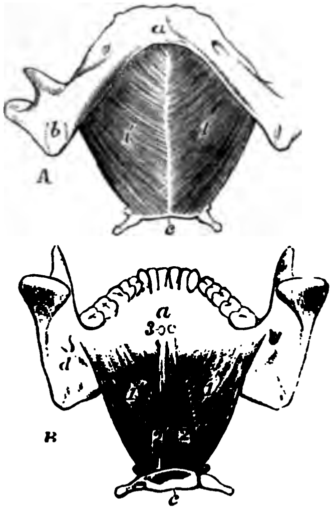


Fig. 201.—A, THE LOWER JAW AND HYOID BONE, FROM BELOW, WITH THE MYLO-HYOID MUSCLES ATTACHED.

B, THE SAME FROM ABOVE AND BEHIND, WITH THE MYLO-HYOID AND GENIO-HYOID MUSCLES ATTACHED. (A. T.) ½

*a*, symphysis; *b*, angle of the lower jaw; *c*, body of the hyoid bone; *d*, in B, the inferior dental foramen and upper end of the mylo-hyoid ridge; 1, 1′, the mylo-hyoid muscles; 2, 2′, the genio-hyoid muscles from above; 3, the cut ends of the attachments of the genio-glossi muscles to the superior mental spines.

*Varieties.*—This muscle may be inseparably united with, and even upon one side in great part replaced by, the anterior belly of the digastric. It frequently receives an accessory slip from one of the other hyoid muscles, as the sterno-hyoid, omo-hyoid, or stylo-hyoid. A deficiency at the fore part of the muscle is of common occurrence, the origin not reaching farther forwards than the canine tooth.

The **genio-hyoid** is a narrow muscle arising from the inferior of the two mental spines behind the symphysis of the jaw, and inserted into the anterior surface of the body of the hyoid bone.

*Relations.*—It is in contact above with the lower border of the genio-glossus muscle, below with the mylo-hyoid, and with its fellow in the middle line.

**Nerves.**—The elevator muscles of the hyoid bone receive their motor nerves from various sources, viz., the anterior belly of the digastric and the mylo-hyoid from the mylo-hyoid branch of the inferior maxillary division of the fifth nerve, the posterior belly of the digastric and the stylo-hyoid from the facial nerve near the place of its exit from the stylo-mastoid foramen, and the genio-hyoid from the hypoglossal.

**Actions of the Muscles of the Front of the Neck.**—The two *sterno-mastoid* muscles acting together bend forwards the head and neck towards the sternum. If one muscle act alone, the head, while it is slightly flexed, is inclined laterally towards the side on which the muscle contracts and rotated to the opposite side. This is the attitude in wry neck which is due to the spasmodic or organic contraction of one sterno-mastoid. Taking their fixed point at the head, they can elevate the upper part of the thorax in forced inspiration.

While the *sterno-hyoid* and *omo-hyoid* muscles act simply as depressors of the hyoid bone, the *sterno-thyroid* muscle, being a direct depressor of the thyroid cartilage, can also draw down the hyoid bone when it acts in conjunction with the *thyro-hyoid*, the latter muscle elevating the larynx when the hyoid bone is fixed. When, in the act of swallowing, the hyoid bone and thyroid cartilage have passed suddenly upwards, their original position is restored by the action of the infra-hyoid muscles. In the utterance of low notes the larynx and hyoid bone descend below the natural level, in the direction of the sternal muscles: while in the utterance of high notes there is little elevation of the hyoid bone, but the larynx is raised by the action of the thyro-hyoid muscles. During deglutition the thyro-hyoid muscles, by drawing the thyroid cartilage up under the hyoid bone, are the principal agents in producing the descent of the epiglottis on the superior of the larynx. The infrahyoid muscles also act with the sterno-mastoid inspiration.

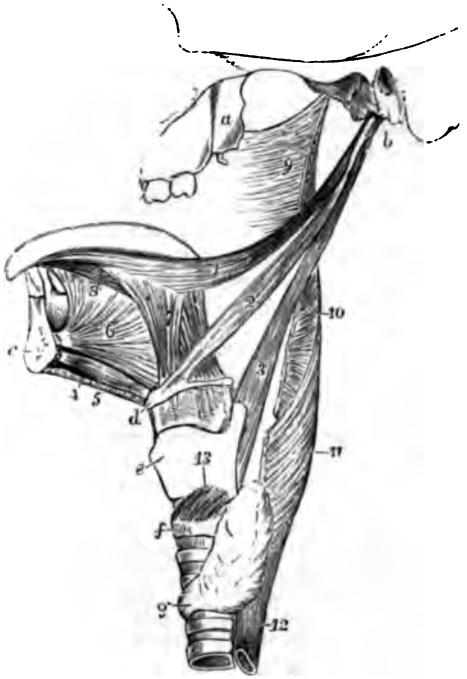
astric, *mylo-hyoid* and *genio-hyoid* muscles are either elevators of the ie, or depressors of the lower jaw, according as one or other of these fixed by the antagonistic muscles. The *stylo-hyoid* acts only on the ie. The mylo-hyoid and genio-hyoid acting alone draw the hyoid bone as well as upwards, while the stylo-hyoid (aided by the middle con- f the pharynx) moves it backwards and upwards. The attachment of stric to the hyoid bone, however, is not close enough to allow of the ent action of the anterior and posterior bellies, and this muscle there- n the jaw is fixed, elevates directly the hyoid bone, as do also the other of this group acting in combination. The mylo-hyoid farther raises the the mouth and presses the tongue against the hard palate, thus forcing s the food in the first stage of deglutition.

### MUSCLES OF THE TONGUE.

ongue is a muscular organ attached posteriorly to the hyoid d inferiorly to the lower jaw. It is composed partly of fibres to itself—the *intrinsic* muscles, which will be noticed with the natomy of the tongue in Vol. II.; and partly of muscles arising ghbouring parts—the *extrinsic* muscles about to be described.

**enio-glossus** or **genio-hyo-glossus** muscle is fan-shaped, and l vertically in contact with its fellow in the mesial plane. It y a short tendon from the superior mental spine behind the is of the jaw: is its fibres di- be inserted, the for the most part, ody of the hyoid d a few into the he pharynx; the into the tip of the tongue; and the intermediate fibres into the ngth of the tongue spreading outwards in its substance.

Fig. 202.



—MUSCLES OF THE PHARYNX, &C., OF T SIDE. (A. T.) ⅓

nal pterygoid plate; process; *c*, section aphysis of the lower body of the hyoid thyroid cartilage; *f*, rtilage; between *d* e thyro-hyoid mem- ligament; *g*, isth- ie thyroid body; 1. s muscle; 2, stylo- stylo-pharyngeus; 4, f the mylo-hyoid; 5, d; 6, genio-glossus; sus; 8, lingualis in- part of the superior of the pharynx; part of the middle ; 11, inferior con- 12, upper part of the ; 13, crico-thyroid

*Relations.*—Its external surface is in contact with the inferior lingualis, hyo-glossus and stylo-glossus muscles, the sublingual gland and the ranine vessels, and its lower border with the genio-hyoid muscle. The terminal portion of the hypoglossal nerve enters its posterior part.

*Varieties.*— Occasional slips of this muscle have been noticed passing to the epiglottis, or to the stylo-hyoid ligament, or more frequently to the small cornu of the hyoid bone. It has also been found united with the genio-hyoid muscle.

The **hyo-glossus** is a flat quadrate muscle, arising from the whole length of the great cornu and from the lateral part of the body of the hyoid bone; it passes upwards to the posterior half of the tongue close to its lateral border, whence the fibres spread forwards and inwards over the dorsum, joining those of the stylo-glossus muscle.

*Relations.*—The hyo-glossus is concealed by the digastric, stylo-hyoid and mylo-hyoid muscles, except at its posterior inferior angle: the deep part of the submaxillary gland rests on its surface, and it is crossed from below upwards by the hypoglossal nerve, the Whartonian duct, and the lingual nerve. It covers the hinder part of the genio-glossus and the origin of the middle constrictor of the pharynx, together with the lingual artery and glosso-pharyngeal nerve.

*Varieties.*—The origin of the muscle is sometimes pierced by the lingual artery. The *triticeo-glossus* (Bochdalek) is a small muscle which arises from the cartilago triticea in the thyro-hyoid ligament, and passes upwards and forwards, lying on the inner side of the lingual artery, to enter the tongue with the posterior part of the hyo-glossus.

The **chondro-glossus** is a small flattened muscular slip, sometimes described as a part of the preceding muscle, from which it is separated, however, by the pharyngeal fibres of the genio-glossus. It arises from the inner side of the base of the small cornu and from part of the body of the hyoid bone, and its fibres are directed upwards and forwards, spreading somewhat, to end on the dorsum of the tongue by side of the middle line. It is sometimes wanting.

The **stylo-glossus**, the shortest of the three muscles which spring from the styloid process, arises from the front of that process near its point, and from the stylo-maxillary ligament, to which in some cases the greater number of its fibres are attached: passing forwards and slightly downwards and inwards, it is inserted along the side and under part of the tongue as far as the tip, its fibres decussating, and becoming blended with those of the hyo-glossus and palato-glossus muscles.

*Relations.*—This muscle lies deeply beneath the parotid gland and angle of the jaw, and is crossed by the lingual nerve.

*Varieties.*—The *mylo-glossus* (Wood) is a small accessory slip, which usually comes from the angle of the lower jaw, but has also been seen coming from the stylo-maxillary ligament. Occasionally the whole muscle arises from one of these points. A very rare origin has been noted by Gruber from the external auditory meatus. Albinus and Böhmer have noted entire absence of the muscle, and various anatomists have seen it double.

**Nerves.**—The muscles of this group are all supplied with branches from the hypoglossal or twelfth cranial nerve.

**Actions.**—The *genio-glossus* muscle has a complicated action, the hinder part protruding, and the fore part retracting the tongue, while the middle part, or nearly the whole muscle, acts as a depressor. The *stylo-glossus* draws the tongue backwards, and elevates its base. It thus comes into play in deglutition. The muscle of one side acting alone gives a lateral direction to the fore part of the tongue. The *hyo-glossus* and *chondro-glossus* retract and depress the tongue. The genio-glossus and stylo-glossus acting together tend to make the dorsum of the tongue concave, while the hyo-glossus produces a convexity.

### MUSCLES OF THE PHARYNX.

The pharynx, the dilated upper part of the alimentary tube extending from the base of the skull to the œsophagus, presents at the sides and back a continuous wall, in great part formed and supported by distinct muscles resting posteriorly against the vertebral column, while in front it is open towards the nasal cavity, the mouth, and the larynx.

The muscles entering into the construction of the wall of the pharynx are disposed in two layers, viz., an outer layer in which the fibres have a generally transverse direction, and an inner one composed of longitudinal fibres. The outer layer includes three muscles named *constrictors*, all of which spring in front from bones or cartilages, and terminate behind, where they are much expanded and overlap one another from below upwards, by joining their fellows in the middle line, forming in the upper part a mesial tendinous raphé. The inner layer comprises the *elevator* muscles of the pharynx, two in number, viz., the stylo-pharyngeus and the palato-pharyngeus, the latter of which will be described together with the muscles of the soft palate.

The **inferior constrictor** muscle, the broadest and thickest of the three, arises by a series of slips from the side of the cricoid cartilage at its lower and posterior part, and from the inferior cornu, the oblique line and upper border of the thyroid cartilage; some fibres are also usually continued into it from the sterno-thyroid and crico-thyroid muscles. It curves backwards and inwards, and unites with its fellow in the middle line at the back of the pharynx. The direction of the inferior fibres is horizontal; the rest ascend with increasing degrees of obliquity, and the highest fibres

Fig. 203.

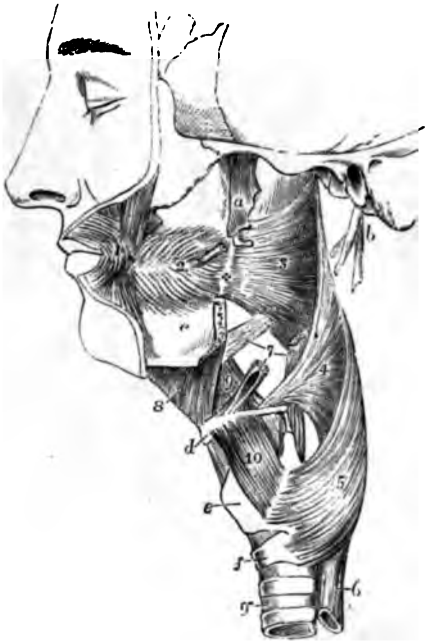


Fig. 203.—DEEP MUSCLES OF THE CHEEK, PHARYNX, &c. (modified from Cloquet). (A. T.) ⅓

The pharynx has been distended by stuffing. *a*, external pterygoid plate; *b*, styloid process with short portions of the three styloid muscles attached; *c*, body of the lower jaw, which has been divided at the place where the pterygo-maxillary ligament + is attached; *d*, body of the hyoid bone; *e*, thyroid cartilage; *f*, cricoid cartilage; *g*, trachea; 1, outer part of the orbicularis oris muscle; 2, buccinator; 3, superior constrictor of the pharynx; 4, middle constrictor; 5, inferior constrictor; 6, œsophagus; 7, points by three lines to the lower parts of the stylo-glossus, stylo-hyoid, and stylo-pharyngeus muscles respectively; 8, mylo-hyoid; 9, hyo-glossus, of which a small part is removed posteriorly to show the attachment of the middle constrictor; 10, thyro-hyoid.

terminate on the raphé about an inch below the basilar process. From its lower border a few fibres turn downwards into the longitudinal fibres of the œsophagus.

*Relations.*—This muscle is in contact posteriorly with the cervical vertebræ and the prevertebral muscles; laterally with the thyroid body, the carotid arteries and the sterno-thyroid muscle. It covers the middle constrictor, the stylo-pharyngeus, the palato-pharyngeus and the mucous membrane of the pharynx. The superior laryngeal nerve and vessels pass inwards to the larynx above its upper border, and the inferior ascend beneath its lower border.

The **middle constrictor** muscle arises from the large and small cornua of the hyoid bone, and from the stylo-hyoid ligament: its fibres, diverging greatly, pass back to the middle line of the pharynx behind, the lowest fibres inclining downwards beneath the inferior constrictor, the highest ascending and overlapping the superior constrictor, and the intermediate fibres running transversely.

*Relations.*—This muscle is separated from the superior constrictor by the stylo-pharyngeus muscle, while between its origin and that of the inferior constrictor the superior laryngeal nerve and vessels pierce the thyro-hyoid membrane.

Fig. 204.

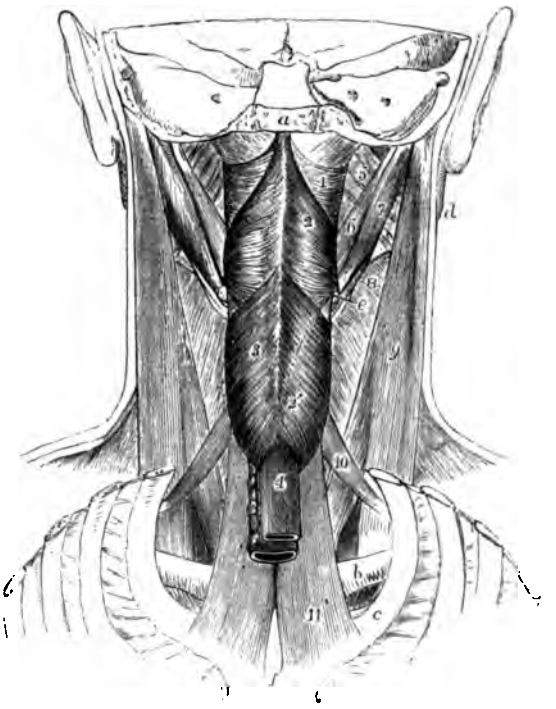


Fig. 204.—VIEW OF THE MUSCLES OF THE PHARYNX, &c., FROM BEHIND (after Bourgery). ½

The back part of the skull, the vertebral column and back parts of the ribs are removed. *a*, cut surface of the basilar process; *b*, clavicle; *c*, first rib; *d*, ramus of the lower jaw; *e*, posterior extremity of the great cornu of the hyoid bone; *f*, posterior surface of the manubrium; 1, superior constrictor muscle of the pharynx; above it the fibrous membrane which closes the pharynx; 2, middle constrictor; 2', a dotted line, indicating the direction of the lower part of the muscle; 3, the inferior constrictor; 4, œsophagus; 5, internal pterygoid; 6, stylo-glossus; 7, posterior belly of the digastric; 8, a portion of the stylo-hyoid surrounding the tendon of the digastric; 9, sterno-mastoid; 10, anterior belly of the omo-hyoid; 11, sterno-thyroid muscle (represented somewhat too broad).

*Varieties.*—The middle constrictor has been seen to receive fibres from the body of the hyoid bone, from the tongue, and from the hinder part of the mylooid ridge of the lower jaw. A slip from the lateral thyro-hyoid ligament (*syndesmo-pharyngeus*, Douglas) is of frequent occurrence.

The **superior constrictor** arises by fibres attached in series from below upwards, to the side of the tongue, to the mucous membrane of the mouth, to the extremity of the mylo-hyoid ridge of the jaw, to the pterygo-maxillary ligament, and to the hamular process and lower third or less of the posterior border of the internal pterygoid plate. The fibres curve backwards, and are mostly blended with those of the corresponding muscle along the middle line, a few ending posteriorly in the aponeurosis which fixes the pharynx to the base of the skull. The upper margin curves round the levator palati and the Eustachian tube; and the space intervening between this concave margin of the constrictor and the base of the skull is closed by fibrous membrane.

*Relations.*—In contact with the outer surface of this muscle are the internal carotid artery. the vagus and sympathetic nerves, the middle constrictor, which overlaps a considerable portion, and the stylo-pharyngeus, which descends to the pharynx between the two constrictors. It conceals the palato-pharyngeus and the tonsil, and is lined by mucous membrane. It is united to the buccinator muscle anteriorly by the pterygo-maxillary ligament.

The constrictor muscles are invested on their outer surface by a layer of dense connective tissue, which is but loosely attached to the adjacent prevertebral fascia. This layer is stronger above than below, and is prolonged forwards over the lateral part of the superior constrictor to the pterygo-maxillary ligament, where it becomes continuous with the membrane covering the buccinator muscle, whence the whole structure is named the *bucco-pharyngeal fascia*.

The **stylo-pharyngeus,** larger and longer than the other styloid muscles, arises from the inner surface of the styloid process near the root, and proceeding downwards and inwards to the side of the pharynx, passes under cover of the middle constrictor muscle, where it gradually expands, and being joined by the palato-pharyngeus, ends on the superior and posterior borders of the thyroid cartilage, and in the lateral wall of the pharynx.

*Relations.*—The external surface of this muscle is, in the upper part of its extent, in contact with the styloid process, and the external carotid artery; in the lower, with the middle and inferior constrictors of the pharynx. Internally it rests on the internal carotid artery and superior constrictor; and lower down on the mucous membrane of the pharynx. The glosso-pharyngeal nerve crosses over the muscle in turning forwards to the tongue.

*Varieties.*—Splitting or doubling of the stylo-pharyngeus is often met with; a division into three parts has also been observed.

Supernumerary elevator muscles of the pharynx are not unfrequently present, arising from a neighbouring part of the base of the skull, and inserted variably into one or other of the constrictors, or passing between those muscles to the fibrous layer of the pharynx. Their most frequent origin is from the under surface of the petrous bone in front of the carotid canal or from the vaginal process of the temporal bone (*petro-pharyngeus*), but they also occur arising from the spine of the sphenoid (*spheno-pharyngeus*), from the hamular process (*pterygo-pharyngeus externus*), or farther back, from the basilar process (*occipito-pharyngeus*), or very rarely from the mastoid process (*pharyngo-mastoideus*). Belonging to the same group is the *azygos pharyngis*, a small median slip sometimes present, arising from the pharyngeal tubercle of the occipital bone, and descending to the raphé or the posterior wall of the pharynx.

*Nerves.*—The constrictor muscles are supplied by the pharyngeal plexus, the inferior also by the external laryngeal nerve. The **stylo-pharyngeus** receives a branch from the glosso-pharyngeal nerve.

### MUSCLES OF THE SOFT PALATE.

The soft palate (velum pendulum palati) is a moveable curtain, continued backwards from the hard palate. It presents posteriorly a free pendulous margin, prolonged in the middle into a conical process, the *uvula*, and at each side into a prominent curved fold, the *posterior pillar of the fauces*, which runs downwards and backwards on the side wall of the pharynx, while from the base of the uvula and the under surface of the soft palate another fold, the *anterior pillar of the fauces*, descends to the tongue ; between the two on each side is lodged the tonsil. The constricted passage between the anterior pillars, leading from the mouth to the pharynx, is called the *isthmus of the fauces*. The soft palate is acted on by five pairs of elongated muscles, two superior, one intermediate, and two inferior.

Fig. 205.

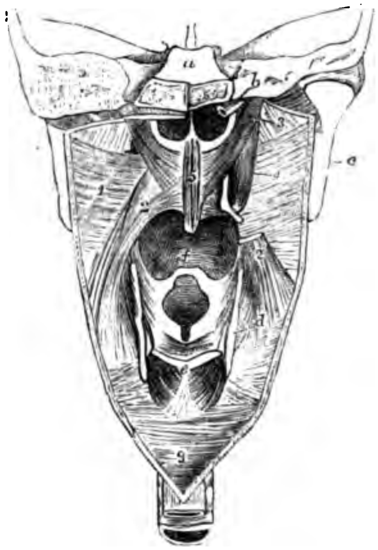


Fig. 205.—DIAGRAMMATIC VIEW OF THE MUSCLES OF THE SOFT PALATE, &c., FROM BEHIND. (A. T.) ½

The posterior wall of the pharynx has been divided by a vertical incision in the middle line, and the cut edges drawn to the side so as to expose the nasal, buccal, and laryngeal openings ; *a*, is above the cut surface of the basilar process, and below that are the posterior nares : *b*, cartilage of the right Eustachian tube ; *c*, back of the ramus of the lower jaw ; *d*, posterior border of the thyroid cartilage ; *e*, upper part of the cricoid cartilage ; *f*, base of the tongue above the epiglottis ; *g*, lower end of the pharynx leading into the gullet ; 1, superior constrictor of the pharynx seen from within ; 2, palato-pharyngeus ; 2′, the lower part of the same muscle, on the right side : 3, placed on the internal pterygoid muscle, points to the levator palati ; 4, the right circumflexus palati muscle winding round the hamular process ; 5, the azygos uvulæ ; above *e*, the arytenoid, and below it on each side the posterior crico-arytenoid muscle.

The **palato-glossus** muscle, or **constrictor isthmi faucium**, occupies the anterior pillar of the fauces. Superiorly it is placed below all the other muscles of the palate, and its fibres are continuous with those of its fellow of the opposite side ; inferiorly it enters the side of the tongue, where it becomes continuous with the transverse fibres of that organ (Henle).

Behind and continuous with the fibres of the palato-glossus are some thin bundles of muscular fibres which ascend from the side of the tongue and are lost over the outer surface of the tonsil. They were named *amygdalo-glossus* by Broca.

The **palato-pharyngeus** arises in the soft palate in two layers which embrace the levator palati and azygos uvulæ muscles. The superficial or upper layer consists of scattered fibres which join those of the opposite muscle in the middle line; the deep or lower layer is much tronger, and partly meets its fellow, partly takes origin from the hinder margin of the hard palate and the aponeurosis of the velum. At the outer border of the soft palate the muscle also receives one or two slender bundles which descend from the lower and fore part of the cartilage of he Eustachian tube (*salpingo-pharyngeus*, Santorini). It then passes downwards and backwards in the posterior pillar of the fauces, becomes considerably expanded, and is inserted, its fibres mingling with those of he stylo-pharyngeus, into the upper and hinder borders of the thyroid cartilage, and into the fibrous layer of the lower part of the pharynx, reaching as far as, or even crossing, the middle line behind.

The **azygos uvulæ** muscle (Morgagni), so called from having been supposed to be a single muscle, consists of two slips, which arise, one on each side of the middle line, from the tendinous structure of the soft palate, sometimes also from the posterior nasal spine, and descend into the uvula. The two slips are separated by a slight interval above, and unite as they descend.

The **levator palati** muscle arises by a narrow tendon from the under surface of the petrous portion of the temporal bone, in front of the orifice of the carotid canal, and from the lower margin of the cartilage of the Eustachian tube. The fibres form a rounded muscle which passes downwards and forwards into the pharynx, crossing the upper border of the superior constrictor. Becoming flattened as it approaches the middle line, its fore part is inserted into the aponeurosis of the palate, while the larger posterior portion meets the muscle of the other side under cover of the azygos uvulæ.

The **circumflexus** or **tensor palati** arises from the navicular fossa at the root of the internal pterygoid plate, from the spine of the sphenoid, and from the outer side of the Eustachian tube. Its flattened belly descends perpendicularly, on the mesial side of the internal pterygoid muscle, and ends in a tendon which, turning round the hamular process, where a synovial bursa smooths its passage, extends horizontally inwards, and is inserted into a transverse ridge on the under surface of the palate bone, and into the aponeurosis of the soft palate.

**Nerves.**—The muscles of this group receive their nerves from various sources some of which are not yet sufficiently determined. The tensor palati receives a branch from the otic ganglion of the fifth nerve, the levator palati and azygos uvulæ from the facial through the petrosal branch of the Vidian, and the palato-glossus and palato-pharyngeus are probably supplied through the pharyngeal plexus.

**Actions of the Muscles of the Pharynx and Soft Palate.**—In considering the mode of action of the *constrictor* muscles it is to be observed that their so-called insertion takes place into a part which, owing to its connections, cannot be moved forwards, and that the constriction of the pharynx takes place therefore mainly by movement backwards of its anterior wall, the cavity being thus converted into a transverse slit. The hyoid bone and larynx are at the same time carried somewhat upwards as well as backwards, in consequence of the oblique direction of the larger number of the fibres of the middle and lower constrictors. The upper part of the superior constrictor differs from the rest in the circumstance that, being placed above the level of the palate, it cannot act directly on the food, and also that its fibres are attached at both ends to parts which are immoveable. The effect of its contraction is consequently to flatten the side-walls of this part of the pharynx, and thus to assist in approximating the posterior pillars fauces. The *stylo-pharyngeus* is the principal elevator of the pharyn larynx. The *palato-glossi*, besides depressing the soft palate and elevati tongue, also bring together the anterior pillars of the fauces, and thus s the mouth-cavity from the pharynx. The *palato-pharyngei* similarly the soft palate and raise the pharynx, but their principal action is to bring to the posterior pillars of the fauces, thus separating the nasal and buccal p of the pharynx. The *azygos uvulæ* raises and shortens the uvula. The ac the *levator palati* is expressed by its name, while the *tensor* not only tight supports the soft palate against pressure from below, and against the trac the depressor muscles, but is also, in the opinion of most anatomists, the by which the Eustachian tube is opened during deglutition. It is prope ever, to remark that a different view is taken by Cleland, who holds— this he, to some extent, agrees with Luschka—that the tube is closed deglutition by the thickening which accompanies the contraction of the palati, pressing up the membranous floor of the canal against the upper an wall, so as completely to obliterate the opening (Journ. Anat., iii. 97).

The muscles of the pharynx and soft palate are so arranged as to accom conjunction with those of the tongue and hyoid bone, the action of deglu that is to say, the propulsion of food into the œsophagus without any being permitted to pass into the nasal cavity or larynx. The first stage operation is effected by the mylo-hyoid, stylo-glossus and palato-glossus which press the tongue against the palate, and so force the food ba through the isthmus of the fauces, the hyoid bone being at the same tim by its proper elevators. The larynx is then carried upwards under the hy by the thyro-hyoid and stylo-pharyngeus muscles, and the root of the being drawn backwards by the stylo-glossi, the epiglottis is pressed dov over the superior aperture of the larynx, which is thus protected. Simult the soft palate is raised and fixed by its superior muscles, and the palato-ph bring together the posterior pillars of the fauces, which nearly touch one (the uvula lying in the small interval between them) and prevent the pa the food towards the upper part of the pharynx or the posterior nares, wh form an inclined surface for its guidance into the lower part of the The food being thus thrown into the grasp of the constrictors of the those muscles contract rapidly from above downwards and force it into of the gullet below.

## DEEP LATERAL AND PREVERTEBRAL MUSCLES OF THE NE

The SCALENI muscles form a group of strong muscular columns are usually three in number, but sometimes only two. All of th subdivided superiorly into musculo-tendinous slips, correspond number with their vertebral attachments.

The **scalenus anticus** muscle is attached superiorly to the tubercles of the transverse processes of the third, fourth, fifth an cervical vertebræ, and inferiorly by a thick flattened tendon scalene tubercle on the upper surface of the first rib.

*Relations.*— This muscle is deeply placed under cover of the sterno-r on its anterior surface lie the subclavian vein, omo-hyoid muscle and nerve; behind are the scalenus medius, the nerves of the brachial ple subclavian artery and the pleura. On its inner side the rectus anticu arises from the same transverse processes, and the ascending cervical ar in the groove between the two muscles, while the internal jugular ve front.

The **scalenus medius** is attached superiorly to the posterior tu of the transverse processes of all the cervical vertebræ (sometimes the atlas), and inferiorly to a rough impression on the first rib, extending from the tubercle to the groove for the subclavian artery.

Fig. 206.

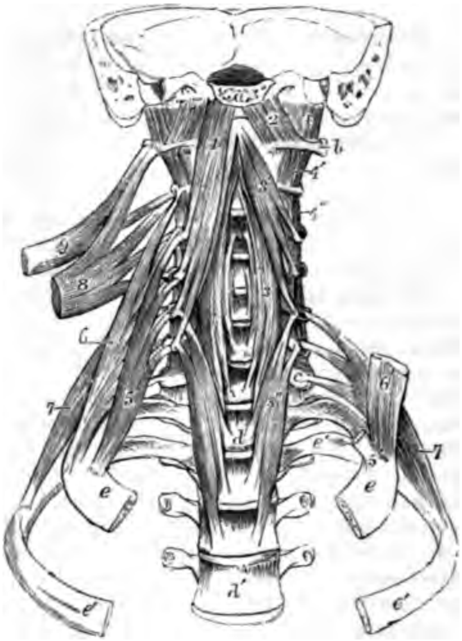


Fig. 206.—THE DEEP LATERAL AND PREVERTEBRAL MUSCLES OF THE NECK FROM BEFORE. (A. T.) ⅓

*a*, cut surface of the basilar process; *b*, transverse process of the atlas; *c*, transverse process of the seventh cervical vertebra; *d*, body of the first, *d'*, of the fourth dorsal vertebra; *e*, first, and *e'*, second rib; 1, rectus capitis anticus major muscle; 2, rectus anticus minor; 3, middle part, 3', upper part, and 3'', lower part of the longus colli; 4, rectus lateralis; 4', first pair, and 4''. second pair of intertransversales; 5, scalenus anticus of the right side; 5', its attachment to the first rib on the left side; 6, scalenus medius; 6', lower portion of the corresponding muscle of the left side; 7, scalenus posticus, its superior attachments shown upon the left side; 8, upper part of the levator scapulæ drawn out from its vertebral attachments; 9, splenius colli, shown in the same manner.

*Relations.*— In front of this muscle, between it and the anterior scalenus, are the cervical nerves and the subclavian artery; behind it are the posterior scalenus and levator anguli scapulæ muscles.

The **scalenus posticus**, smaller than the other scaleni muscles, is attached above by two or three small tendons to the transverse processes of as many of the lower cervical vertebræ, and inferiorly by an aponeurotic tendon to the second rib external to the attachment of the levator costæ.

*Varieties.*—The scaleni muscles are subject to a considerable amount of variation, both in the number of their points of attachment, and in the arrangement of their fibres. A slip from the scalenus anticus sometimes passes behind the subclavian artery. The scalenus posticus is not unfrequently absent.

The PREVERTEBRAL muscles of the cervical region are three in number, two of which pass to the head from the upper vertebræ, viz., the rectus capitis anticus major and minor, and the third is confined to vertebral attachments, the longus colli. Along with these the rectus capitis lateralis muscle may also be described in this place.

The **rectus capitis anticus major** muscle arises by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ: it is inserted into the basilar process of the occipital bone, a little in front of the foramen magnum.

The muscles of opposite sides converge as they ascend, and their mesial fibres are longest.

*Relations.*—Its anterior surface supports the pharynx, the sympathetic and vagus nerves, and the great cervical vessels. The posterior surface rests upon the vertebræ, part of the longus colli and the rectus anticus minor.

The **rectus capitis anticus minor,** partly covered by the major, arises from the front of the root of the transverse process of the atlas, and is inserted into the basilar process, between the margin of the foramen magnum and the preceding muscle, half an inch from its fellow.

The **rectus capitis lateralis** is a short thick muscle arising from the upper and fore part of the enlarged extremity of the transverse process of the atlas, and inserted into the rough under surface of the jugular process of the occipital bone. This and the foregoing muscle complete the series of intertransversales muscles, which are described along with the deep posterior muscles of the neck.

The **longus colli** muscle rests on the front of the vertebral column from the atlas to the third dorsal vertebra; it consists of three sets of fibres, of which one is vertical and two are oblique. *a.* The *vertical part* arises by a series of flattened muscular and tendinous processes from the bodies of the lower two cervical and upper two or three dorsal vertebræ, and along its outer border it receives slips also from the transverse processes of the lower three or four cervical vertebræ; it is inserted into the bodies of the second, third and fourth cervical vertebræ. *b.* The *lower oblique* part, the smallest of the three, takes origin in common with the vertical part from the bodies of the upper dorsal vertebræ, and is inserted by narrow tendinous slips into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. *c.* The *upper oblique* part arises by separate tendinous slips from the anterior tubercles of the transverse processes of the third, fourth and fifth cervical vertebræ, and is inserted into the lateral part of the tubercle on the anterior arch of the atlas, becoming connected also with the upper end of the vertical part.

*Relations.*—By its anterior surface the longus colli muscle is in contact with the pharynx and œsophagus, the great vessels of the neck contained in their sheath, the sympathetic and recurrent laryngeal nerves, and the inferior thyroid artery. Behind, it rests upon the vertebræ.

*Varieties.*—The number of attachments, and the degree of separation of the several parts are subject to variation. A slip of the lower oblique part is sometimes inserted into the head of the first rib, or a fasciculus may be continued into the rectus capitis anticus major.

**Nerves.**—The rectus anticus minor and rectus lateralis are supplied by branches from the first cervical nerve; the scaleni and long prevertebral muscles receive branches from the adjacent cervical nerves.

**Actions.**—The scalene muscles, acting from their vertebral attachments, are elevators of the upper ribs and thus come into play in the movement of inspiration, especially in laboured breathing, while in tranquil respiration a moderate degree of action suffices to fix the first rib and support the lung where it projects through the upper aperture of the thorax. Taking their fixed point at the ribs, they act as lateral flexors of the neck, and the muscles of the two sides, acting together, especially the anterior scaleni, can bend the neck forwards. [illegible] flexors of the head on the spine, and the *rectus lateralis* [illegible] side. The longus colli is chiefly a flexor of the neck, [illegible] oblique parts may produce a certain amount of rotation.

## IV.—MUSCLES AND FASCIÆ OF THE TRUNK.

The muscles passing between the trunk and the upper limb having en already described, those which belong exclusively to the trunk elf will now be treated of under the three heads of, 1. Dorsal muscles; Thoracic muscles, including the diaphragm; and 3. Abdominal d Perineal muscles.

### DORSAL MUSCLES AND FASCIÆ.

The muscles to be described under the above head, taken as a whole, cupy the hollow between the line of vertebral spines and the prominences rmed by the mastoid process, the cervical transverse processes, the ost projecting parts of the ribs, and the crest of the ilium, and they tend from the superior curved line of the occipital bone to the lower rt of the sacrum. Some of them are small and are limited to certain rts of the extensive region now referred to; others extend, either coninuously or by the serial repetition of similar short fasciculi, throughout he greater part of it. They may be arranged for purposes of description, ccording to the order in which they occur, in the following groups, viz., *a*, the posterior serrati muscles; *b*, the splenius; *c*, the erector spinæ; *d*, the complexus and transverso-spinales; *e*, the interspinales and intertransversales; *f*, the short cranio-vertebral muscles. Of these muscles the serrati act solely on the ribs and are closely related to the thoracic muscles, although from their position they are most conveniently described in this place. The remainder act on the spinal column and head, and considered with regard to the direction of their fibres fall into three main divisions. In the first division (splenius) the muscular fibres are directed obliquely upwards and outwards, or from spinous to transverse processes; in the second (transverso-spinales and complexus) the fibres pass obliquely upwards and inwards or from transverse to spinous processes; in the third the fibres run longitudinally between corresponding parts of the vertebræ, being either of considerable length and passing over several segments (erector spinæ), or short and attached to adjacent vertebræ (interspinales and intertransversales). The short cranio-vertebral muscles may be regarded as presenting examples of each of these divisions.

SERRATI MUSCLES.—The **serratus posticus superior** is a thin flat muscle which is covered, excepting at its upper border, by the rhomboid and levator anguli scapulæ muscles. It arises from the lower part of the ligamentum nuchæ, from the spines of the last cervical and two or three upper dorsal vertebræ, and from the supraspinous ligament, by a thin aponeurotic tendon forming nearly half of the length of the muscle. The fibres are directed obliquely downwards and outwards, and form four fleshy digitations which are inserted by tendinous extremities into the upper borders and outer surfaces of the second, third, fourth and fifth ribs, a little beyond their angles.

*Varieties.*— The slips are sometimes only three in number; or less frequently there are five or even six (Henle). In very rare cases absence of the muscle has been observed (Macalister, Proc. Roy. Irish Acad., 1866).

The **serratus posticus inferior** (fig. 157, p. 195), broader and tronger than the superior, arises from the spines of the lower two dorsal

The muscles of opposite sides converge as they ascend, and their mesial fibres are longest.

*Relations.*—Its anterior surface supports the pharynx, the sympathetic and vagus nerves, and the great cervical vessels. The posterior surface rests upon the vertebræ, part of the longus colli and the rectus anticus minor.

The **rectus capitis anticus minor,** partly covered by the major, arises from the front of the root of the transverse process of the atlas, and is inserted into the basilar process, between the margin of the foramen magnum and the preceding muscle, half an inch from its fellow.

The **rectus capitis lateralis** is a short thick muscle arising from the upper and fore part of the enlarged extremity of the transverse process of the atlas, and inserted into the rough under surface of the jugular process of the occipital bone. This and the foregoing muscle complete the series of intertransversales muscles, which are described along with the deep posterior muscles of the neck.

The **longus colli** muscle rests on the front of the vertebral column from the atlas to the third dorsal vertebra; it consists of three sets of fibres, of which one is vertical and two are oblique. *a.* The *vertical* part arises by a series of flattened muscular and tendinous processes from the bodies of the lower two cervical and upper two or three dorsal vertebræ, and along its outer border it receives slips also from the transverse processes of the lower three or four cervical vertebræ; it is inserted into the bodies of the second, third and fourth cervical vertebræ. *b.* The *lower oblique* part, the smallest of the three, takes origin in common with the vertical part from the bodies of the upper dorsal vertebræ, and is inserted by narrow tendinous slips into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. *c.* The *upper oblique* part arises by separate tendinous slips from the anterior tubercles of the transverse processes of the third, fourth and fifth cervical vertebræ, and is inserted into the lateral part of the tubercle on the anterior arch of the atlas, becoming connected also with the upper end of the vertical part.

*Relations.*—By its anterior surface the longus colli muscle is in contact with the pharynx and œsophagus, the great vessels of the neck contained in their sheath, the sympathetic and recurrent laryngeal nerves, and the inferior thyroid artery. Behind, it rests upon the vertebræ.

*Varieties.*—The number of attachments, and the degree of separation of the several parts are subject to variation. A slip of the lower oblique part is sometimes inserted into the head of the first rib, or a fasciculus may be continued into the rectus capitis anticus major.

**Nerves.**—The rectus anticus minor and rectus lateralis are supplied by branches from the first cervical nerve; the scaleni and long prevertebral muscles receive branches from the adjacent cervical nerves.

**Actions.**—The *scalene* muscles, acting from their vertebral attachments, are elevators of the upper ribs, and thus come into play in the movement of inspiration, contracting forcibly in laboured breathing, while in tranquil respiration a moderate degree of action suffices to fix the first rib and support the lung where it projects through the upper aperture of the thorax. Taking their fixed point at the ribs they act as lateral flexors of the neck, and the muscles of the two sides acting together (especially the anterior scaleni) can bend the neck forwards. The *recti antici* are flexors of the head on the spine, and the *rectus lateralis* can only bend the head to the side. The *longus colli* is chiefly a flexor of the neck, but its upper and lower oblique parts may produce a certain amount of rotation.

passes beneath the superior serratus; below, it is blended with the tendons of the latissimus and inferior serratus muscles, and in being stretched from the spinous processes outwards to the angles of the ribs, it helps to enclose the angular space in which are lodged the long extensor muscles.

Under the name of **lumbar fascia** or **aponeurosis** it has been customary to describe three strong membranous layers ensheathing the erector spinæ and quadratus lumborum muscles. The deeper parts of this structure, to which by some the name of lumbar fascia is restricted, will be described along with the abdominal muscles, with which they are chiefly connected. The *superficial* or *posterior layer* is that through which the latissimus dorsi and serratus posticus inferior muscles are attached to the spines of the vertebræ. This layer, which is of considerable strength, extends outwards beyond the origin of the latissimus and serratus inferior, and becoming closely united with the middle layer, binds down firmly the erector spinæ muscle: it is by some described as the lower part of the vertebral aponeurosis, with which it is continuous, by others it has been named the aponeurosis of the latissimus dorsi.

The SPLENIUS muscle is so named from its having the form of a strap, which binds down the parts lying under it. It is attached superiorly in part to the cervical vertebræ, in part to the skull, and is described accordingly under two names.

*a.* The **splenius colli** is attached inferiorly to the spinous processes of the third, fourth, fifth and sixth dorsal vertebræ, and superiorly along with the slips of the levator anguli scapulæ to the transverse processes of the first two or three cervical vertebræ.

*b.* The **splenius capitis,** broader and thicker than the preceding, arises from the spines of the seventh cervical and two upper dorsal vertebræ, and from the ligamentum nuchæ as high as the third cervical vertebra. It is inserted into the lower part of the mastoid process, and into the outer part of the superior curved line of the occipital bone.

*Relations.*—The splenius is covered below and internally by the trapezius, the rhomboids and the serratus posticus superior; and at its insertions by the sterno-mastoid and levator anguli scapulæ. It conceals, in part, the complexus and trachelo-mastoid.

*Varieties.*—The origin of the splenius is frequently moved upwards to the extent of one or two vertebræ. The *rhombo-atloideus* (Macalister) is a muscular slip occasionally present, arising from one or two lower cervical or upper dorsal spines, superficial to the serratus posticus superior, and inserted into the transverse process of the atlas.

ERECTOR SPINÆ.—This is a large composite muscle, extending throughout the whole length of the back from the pelvis to the head, and divided for purposes of description into seven parts, to which distinct names are applied. Commencing below as a common mass, it is continued upwards in three columns, of which the innermost, *spinalis dorsi,* is comparatively slender and short, while the other two are much thicker, and are again subdivided each into three portions, viz., in the outer column, *ilio-costalis, accessorius,* and *cervicalis ascendens,* and in the middle column, *longissimus dorsi, transversalis cervicis,* and *trachelo-mastoid.*

The origin of the erector spinæ takes place mainly by means of a strong flattened tendon which is attached to the lowest two or three dorsal and all the lumbar and sacral spines, to the posterior fifth of the iliac crest, and to the lower and back part of the sacrum, as well as to the ligaments

Fig. 208.

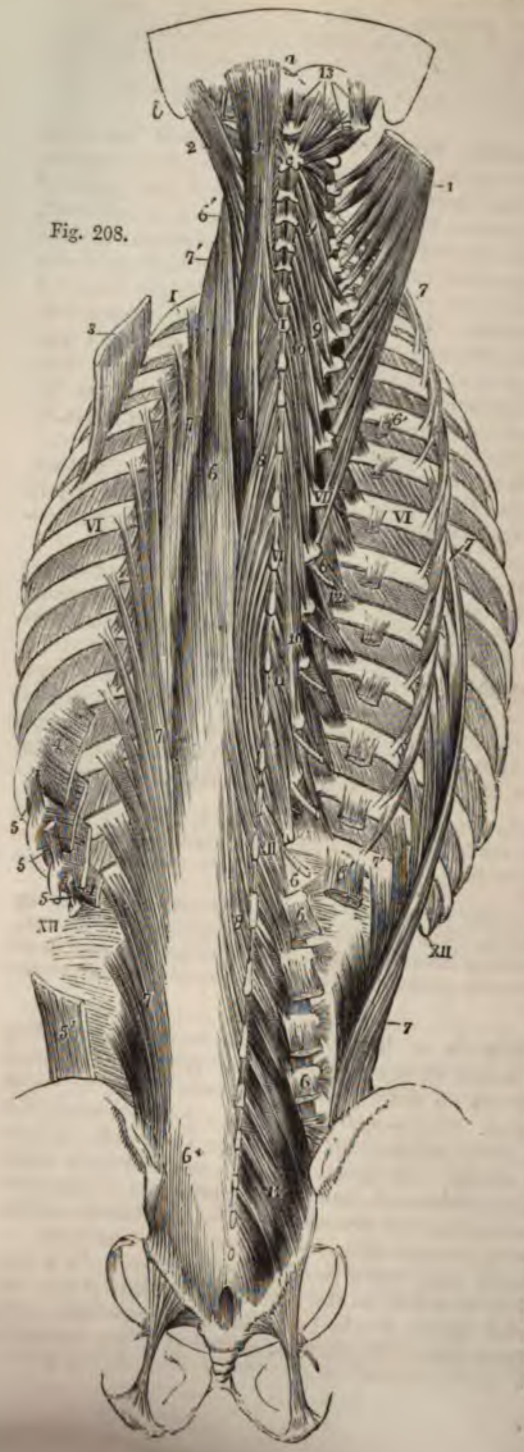


Fig. 208.—DEEP MUSCLES OF THE BACK. (A. T.) ¼

On the left side the several parts of the erector spinæ are nearly in their natural position, with the exception of the spinalis dorsi, which is drawn out from the spines of the vertebræ; on the right side the spinalis dorsi has been entirely removed, the ilio-costalis drawn to the outer side so as to expose its accessory muscle, and the longissimus removed, excepting small portions at its insertions. Superiorly on the left side, the trachelo-mastoid and complexus are left nearly in their natural positions; while, on the right side, the trachelo-mastoid has been entirely removed, and the complexus, separated from its occipital attachment, has been spread out so as to stretch its vertebral attachments. *a*, external occipital protuberance; *b*, mastoid process; *c*, spinous process of the axis; I, I, spinous process of the first dorsal vertebra and first rib; VI, VI, VI, sixth dorsal spine and transverse process and sixth rib; XII, XII, twelfth dorsal spine and twelfth rib. *On the left side*, 1, complexus; 2, trachelo-mastoid; 3, serratus posticus superior, detached from the spine and drawn upwards from the ribs; 4, 4, the slips of attachment of the serratus posticus inferior to the lowest four ribs; 5, 5, 5, costal, and 5′, iliac origins of the latissimus dorsi; 6 +, tendon of origin of the erector spinæ; 6, upper part of the longissimus dorsi; 6′, transversalis cervicis continued up from the longissimus; 7, ilio-costalis drawn slightly inwards to show the slips of insertion into the lumbar fascia and the various ribs; inside the costal insertions are seen the origins of the accessorius; 7′, cervicalis ascendens continued upwards from the accessorius; 8, spinalis dorsi. *On the right side*, 6, marks, in the lumbar region, the insertions of the longissimus dorsi into the upper four transverse processes (the insertion into the accessory processes not being shown); in the dorsal region the narrower tendons of insertion into the lower part of the dorsal transverse processes (the six lower only are represented); 6′, 6′, the costal insertions; 7, ilio-costalis, drawn outwards; 7′, placed between the lowest insertion of the ilio-costalis and the lowest origin of the accessorius; 7″, cervicalis ascendens; 9, 9, semispinalis colli; 10, 10, semispinalis dorsi; 11, 11, lower dorsal and lumbar parts of the multifidus spinæ, which appears again above the semispinalis colli, above the upper 9; 12, levatores costarum, long and short; 13, in the upper part of the figure, points by four lines to the rectus capitis posticus minor and major, and the obliquus inferior and superior muscles.

uniting that bone to the coccyx. This tendon becomes blended below with the overlying layer of the lumbar fascia; its deep surface gives origin also to some fibres of the multifidus spinæ, and between the iliac and sacral attachments a part of the gluteus maximus arises from its border. The fasciculi of which it is composed pass nearly vertically upwards, the outer ones, above the iliac crest, being very short, while the inner ones ascend by side of the spines to the middle of the dorsal region. The fleshy fibres of the muscle are derived mostly from the oblique upper border and the deep surface of the tendon, but others spring directly from the rough posterior part of the inner surface of the ilium, beneath and outside the attachment of the tendon. The lower part of the muscle forms a large mass which projects backwards beyond the spines, and laterally beyond the transverse processes of the lumbar vertebræ, and which becomes divided below the level of the last rib into the middle and outer columns. The inner column only separates itself from the middle column in the upper dorsal region.

*a.* The **ilio-costalis** or **sacro-lumbalis,** the first portion of the outer column, is continued from the outer and superficial portion of the common mass; it ends in a series of tendons which incline slightly outwards, and are inserted one into each of the lower six or seven ribs at their angles, a slender fasciculus being usually prolonged also into the accessorius.

*b.* The **musculus accessorius** ad ilio-costalem (ad sacro-lumbalem) prolongs upwards the preceding muscle. It arises by flat tendons from the upper margins of the lower six ribs, internal to the tendons of the ilio-costalis, and ends superiorly by continuing the series of those tendons to the angles of the upper ribs, and to the transverse process of the seventh cervical vertebra.

*c.* The **cervicalis ascendens** consists of slips in serial continuation with the foregoing, taking origin from four or five ribs above the accessorius, and inserted into the posterior tubercles of the transverse processes of the fourth, fifth and sixth cervical vertebræ. Its insertions are intimately connected with those of the transversalis cervicis.

*d.* The **longissimus dorsi** is both larger and longer than the ilio-costalis, its original fibres passing as high as the first dorsal vertebra. Internally it is closely connected on the surface with the spinalis dorsi, the tendinous slips springing from the upper two or three lumbar vertebræ being common to the two muscles. When those slips and the tendons of origin from the lumbar spines are cut through the inner surface of the muscle is brought into view, and it is then usually seen to receive from two to four slender accessory tendons from the lower dorsal transverse processes. The longissimus dorsi presents two series of insertions. The inner row of insertions is a series of rounded tendons attached to the transverse processes of all the dorsal, and the accessory processes of the lumbar vertebræ. The outer insertions form a series of thin fleshy processes which are attached in the dorsal region to the lowest nine or ten ribs, between their tubercles and angles, and in the lumbar region to the whole length of the transverse processes, and beyond these to the lumbar fascia connected with them.

*e*. The **transversalis cervicis** muscle prolongs upwards the column of fibres of the longissimus dorsi. It arises from the transverse processes of the highest four or five dorsal vertebræ, and occasionally the last cervical, and is inserted into the posterior tubercles of the transverse processes of five cervical vertebræ, from the second to the sixth inclusive. It generally receives a slip of the original fibres of the longissimus dorsi.

*f*. The **trachelo-mastoid** muscle (transversalis capitis), which may be regarded as the continuation of the longissimus dorsi to the head, arises in close connection with the transversalis cervicis from the upper dorsal transverse processes, and also from the articular processes of the lower three or four cervical vertebræ, and, forming a thin flat muscle, passes to be inserted into the posterior margin of the mastoid process, under cover of the splenius and sterno-mastoid muscles. It is the only muscle which lies between the splenius and complexus, and the only portion of the erector spinæ concealed by the former. It is usually crossed by a tendinous intersection a little below its insertion.

*g*. The **spinalis dorsi** is a long narrow muscle placed at the inner side of the longissimus dorsi, and closely connected with it. It receives the slender tendinous fasciculi from the lowest two or three dorsal spines, and other fleshy fibres spring from the tendons which pass from the upper lumbar spines into the longissimus. Its insertion takes place into a variable number, from four to nine, of the upper dorsal spines, the slips being closely adherent to those of the subjacent semispinalis muscle.

*Varieties.*—The *spinalis cervicis* is an inconstant muscle, arising variably from the ligamentum nuchæ and the seventh cervical spine, or from one or two spines above or below this, and inserted mainly into the spine of the axis, occasionally also into those of the third and fourth cervical vertebræ. (See Henle and Heilenbeck, Müller's Archiv, 1837).

The name *sacro-coccygeus posticus*, or *extensor coccygis*, has been given to slender fibres occasionally found extending from the lower end of the sacrum to the coccyx, and representing the extensor of the caudal vertebræ of the lower animals.

COMPLEXUS AND TRANSVERSO-SPINALES.—The muscles of this group, comprising the complexus, semispinalis, multifidus spinæ, and rotatores dorsi, present the feature in common of ascending with an inward inclination, and are thus distinguished from those last described. The most superficial, the complexus, has the longest and most vertical fibres, but is the shortest in its whole extent, being limited to the upper part of the dorsal and the cervical regions; the muscle beneath it, the semispinalis, occupies the greater part of both those regions; the multifidus spinæ, still more deeply placed, extends from the sacrum to the axis; and the rotatores dorsi, the deepest of all, are confined to the thoracic region.

The **complexus** muscle (semispinalis capitis) arises by tendinous slips from the transverse processes of the upper six or seven dorsal and the last cervical vertebræ, and from the articular processes of the three and sometimes four succeeding cervical vertebræ, together with the

r ligaments uniting them ; it is also frequently joined by one or
nder fasciculi from the lowest cervical or highest dorsal spines.
serted into the large internal impression between the two curved
f the occipital bone. It is narrower above than below, and its
ıargin in the neck is in contact with the ligamentum nuchæ. An
ır, commonly imperfect, tendinous intersection crosses the muscle
he level of the spine of the axis ; and lower down, another longer
errupts the fibres of the inner portion of the muscle, which is
r less separate from the rest, and is hence sometimes described
ıdently under the name of *biventer cervicis.*

*ions.*—The complexus muscle is covered by the splenius, except at its
rigins from the dorsal vertebræ and at the internal portion of its upper
ty ; the trachelo-mastoid and transversalis cervicis rest upon its series of
and the semispinalis colli, the posterior recti, and the obliqui capitis,
with the deep cervical artery, are concealed by it.

**semispinalis** muscle consists of bundles of fibres extending from
rse processes to spines, and crossing over from four to six
æ. It is described in two parts.

he *semispinalis colli* is the part under cover of the complexus. It
rom the upper five or six dorsal transverse processes, and is in-
into the spines of the cervical vertebræ from the second to the
clusive, being thickest at its insertion into the second vertebra.

he *semispinalis dorsi* consists of narrow muscular bundles inter-
between tendons of considerable length, and forms an elongated
ratum, especially towards its lower border. It arises from the
rse processes of the dorsal vertebræ from the sixth to the tenth
re, and is inserted into the last two cervical and from four to six
lorsal spines.

**multifidus spinæ** muscle occupies the vertebral groove by side
row of spinous processes, reaching from the sacrum to the axis,
assing up under cover of the semispinalis. It is much more
developed towards the lower than at the upper end of the
ı and is thinnest in the dorsal region. In the sacral region the
rise from the deep surface of the tendinous origin of the erector
from the groove on the back of the sacrum as low as the fourth
n, from the inner part of the posterior extremity of the ilium, and
he posterior sacro-iliac ligament ; in the lumbar region they take
from the mammillary processes ; in the dorsal region from the
rse processes ; and in the neck from the articular processes of
ır lower cervical vertebræ. From these several points the mus-
undles ascend obliquely, to be inserted into the spines of the
æ, from their bases to their extremities. The fibres from each
f origin are fixed to several vertebræ, some being inserted into the
the spinous process next but one above, and others ascending more
ore vertically as high as the fourth from the place of origin, the
fibres from one origin overlapping those from the origin next above.

**rotatores dorsi** are eleven small muscles on each side, which may
rded as the deepest fibres of the multifidus spinæ in the dorsal
and are distinguished by being more nearly horizontal than the
Each arises from the upper and back part of the transverse process
vertebra, and is inserted into the inferior margin of the lamina of
tebra next above. Similar small slips between adjacent vertebræ,

insertions. The inner row of insertions is a series of rounded tendons attached to the transverse processes of all the dorsal, and the accessory processes of the lumbar vertebræ. The outer insertions form a series of thin fleshy processes which are attached in the dorsal region to the lowest nine or ten ribs, between their tubercles and angles, and in the lumbar region to the whole length of the transverse processes, and beyond these to the lumbar fascia connected with them.

*e.* The **transversalis cervicis** muscle prolongs upwards the column of fibres of the longissimus dorsi. It arises from the transverse processes of the highest four or five dorsal vertebræ, and occasionally the last cervical, and is inserted into the posterior tubercles of the transverse processes of five cervical vertebræ, from the second to the sixth inclusive. It generally receives a slip of the original fibres of the longissimus dorsi.

*f.* The **trachelo-mastoid** muscle (transversalis capitis), which may be regarded as the continuation of the longissimus dorsi to the head, arises in close connection with the transversalis cervicis from the upper dorsal transverse processes, and also from the articular processes of the lower three or four cervical vertebræ, and, forming a thin flat muscle, passes to be inserted into the posterior margin of the mastoid process, under cover of the splenius and sterno-mastoid muscles. It is the only muscle which lies between the splenius and complexus, and the only portion of the erector spinæ concealed by the former. It is usually crossed by a tendinous intersection a little below its insertion.

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SHORT POSTERIOR CRANIO-VERTEBRAL MUSCLES.—The **rectus capitis posticus major** muscle arises by a narrow tendon from the spinous process of the axis, and expanding as it passes upwards and outwards, is inserted into and beneath the outer part of the inferior curved line of the occipital bone. Its insertion is inside and below that of the superior oblique muscle.

The **rectus capitis posticus minor** muscle arises from the posterior arch of the atlas by the side of the tubercle, and expands as it passes upwards to be inserted into the inner third of the inferior curved line of the occipital bone, and the depression between that and the foramen magnum.

The **obliquus capitis inferior**, the strongest of the muscles now under consideration, arises from the spinous process of the axis, between the origin of the rectus posticus major and the insertion of the semispinalis colli, and is inserted into the lower and back part of the transverse process of the atlas.

The **obliquus capitis superior**, smaller than the preceding muscle, arises from the upper surface of the transverse process of the atlas, thence inclines obliquely upwards and backwards, increasing in breadth as it ascends, and is inserted into an impression between the outer parts of the curved lines of the occipital bone.

*Relations.*—The two oblique muscles with the rectus major form the sides of a small triangular space, in the area of which the posterior primary branch of the suboccipital nerve and the vertebral artery are found.

**Nerves.**—All the muscles of the back which act upon the head and spine, viz., the splenius, erector spinæ, complexus, and the muscles more deeply seated are supplied by the posterior primary branches of the spinal nerves.

**Actions of the Dorsal Spinal and Cranial Muscles.**—In extending the spinal column and head not only the *erector spinæ*, but all the muscles of this group come into play, necessarily acting simultaneously on both sides. Acting on one side alone they produce the lateral flexion of the column. While the action of the longitudinally directed muscles is limited to these movements, the oblique muscles are farther enabled to rotate the head and spinal column. Thus, when the *splenius* of one side acts it rotates the head and neck to the same side, while the *complexus* and *transverso-spinales* rotate the head and spine to the opposite side. The power of the extensor muscles to straighten the back from the flexed condition, as measured by the muscular dynamometer, varies in adults of medium strength from 200 lbs. to 400 lbs. A certain amount of extension of the spine, as will be hereafter explained, accompanies inspiration; but if the spine be fixed, some of the erector muscles may, by their costal attachments, depress the ribs, and thus assist in forced expiration.

Of the short cranio-vertebral muscles, two—the *rectus minor* and *superior oblique*—act principally by drawing the head backwards, that being the chief movement allowed between the atlas and occipital bone; while the principal action of the *rectus posticus major* and the *inferior oblique*, when acting on one side, is to rotate the atlas and skull upon the axis, the former muscle also assisting in the extension of the head.

but more longitudinal in direction, are occasionally present in the cervical and lumbar regions.

INTERSPINALES AND INTERTRANSVERSALES.—The **interspinales** are short vertical fasciculi of fleshy fibres, placed in pairs between the spinous processes of contiguous vertebræ. In the neck, from the axis downwards, they are roundish bundles attached to the two parts into which the spinous processes are divided. In the dorsal region they are for the most part absent, a few fibres only being present in one or two of the highest and lowest spaces. In the loins they are flattened bands, one on each side of the interspinous ligament, and extending the whole length of the spinous processes.

*Variety.*—Longer interspinous bundles are sometimes found in the neck passing over one or two vertebræ, and forming a transition to the spinalis cervicis muscle already described.

The **intertransversales** are short muscles passing nearly vertically from vertebra to vertebra between the transverse processes. In the cervical region there are two rounded fleshy bundles beneath each transverse process, the one descending from the anterior, the other from the posterior part of the process. In the dorsal region there are small fleshy bundles in the lowest three or four spaces; in the middle spaces they are replaced by small tendinous bands which constitute the so-called inter-

Fig. 209.

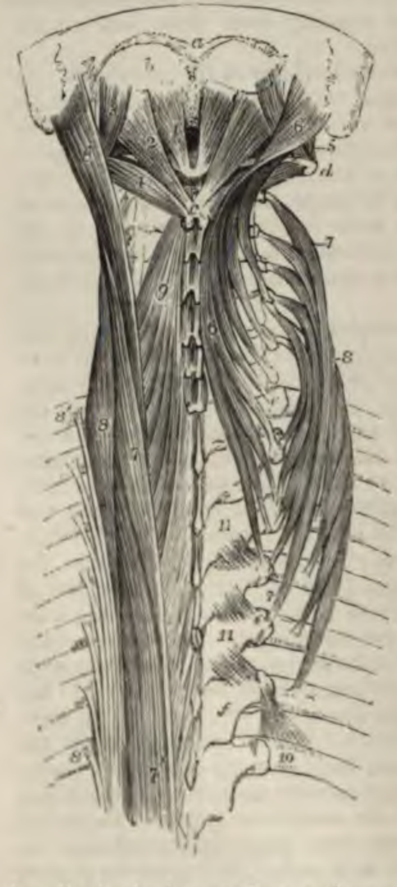

Fig. 209.—DEEP POSTERIOR MUSCLES OF THE UPPER PART OF THE VERTEBRAL COLUMN. (A. T.) ½

*a*, external occipital protuberance; *b*, surface between the superior and inferior curved lines into which the complexus is inserted; *c*, spinous process of the axis; *d*, transverse process of the atlas; *e*, transverse process of the first dorsal vertebra; *f*, lamina of the sixth dorsal vertebra; 1, rectus capitis posticus minor muscle; 2, rectus posticus major; 3, obliquus superior; 4, obliquus inferior; 5, rectus capitis lateralis; 6, 6, trachelo-mastoid, the muscle of the right side turned inwards and its slips of attachment to the dorsal and cervical vertebræ separated from each other; 7, 7, transversalis cervicis, the figures are placed near the extreme ends of the muscle on the right side; 7′, on the left side, longissimus dorsi; 8, 8, cervicalis ascendens, the muscle of the right side is spread out; 8′, 8′, on the left side, tendinous insertions of the ilio-costalis and accessorius muscles; 9, upper part of the semispinalis colli of the left side; 10, placed on the seventh rib of the right side close to the insertion of its levator costæ muscle; 11, 11, three rotatores dorsi.

ransverse ligaments; and in the upper spaces they are usually ltogether wanting. In the lumbar region there are again two sets: one et, the *intertransversales laterales*, lie between the transverse processes, nd are in series with the levatores costarum; the other set, *intertransverales mediales* or *interaccessorii*, pass from the accessory process of one ertebra to the mammillary process of the next, and are in series with he intertransversales of the dorsal region.

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## MUSCLES OF THE THORAX.

The muscles of the thoracic wall are the intercostals, levatores costarum, subcostals, and triangularis sterni, and along with these the diaphragm intervening between the thorax and abdomen may conveniently be grouped.

The INTERCOSTAL MUSCLES consist of two thin layers of short oblique fibres occupying the intercostal spaces : these layers are named respectively the external and internal muscles.

Fig. 210.

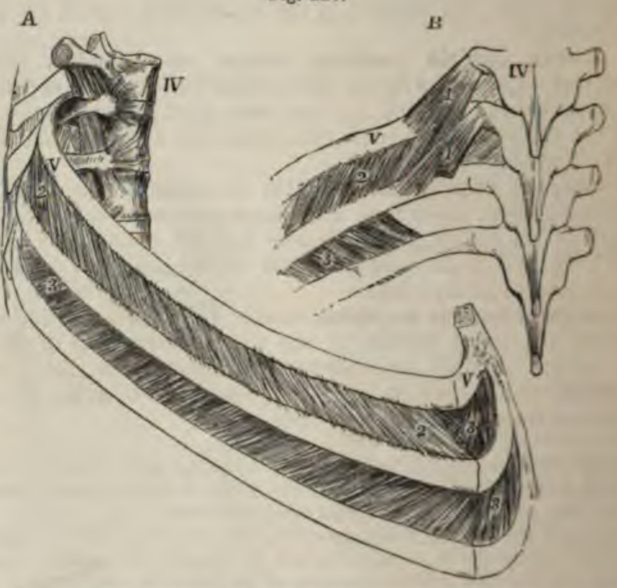


Fig. 210.—INTERCOSTAL MUSCLES OF THE FIFTH AND SIXTH SPACES (after Cloquet. (A. T.) $\frac{1}{3}$

A, from the side ; B, from behind.

IV, fourth dorsal vertebra ; V, V, fifth rib and its cartilage; 1,1, levatores costarum muscles, short and long ; 2, 2, external intercostal muscle ; 3, 3, the internal intercostal layer, shown in the lower space by the removal of the external layer, and seen in A in the upper space, in front of the external layer : the deficiency of the internal layer towards the vertebral column is shown in B.

The **external intercostal** muscles are stronger than the internal. Their fibres are intermixed with a considerable quantity of tendinous substance, and are directed obliquely downwards and forwards from the prominent lower margin of one rib to the upper border of the next. The extent of these muscles is generally from the tubercles of the ribs to the outer ends of the cartilages ; but in the upper three or four spaces they do not quite reach the ends of the ribs, while in the last two intervals they are continued forwards between the cartilages. Beyond the points at which the muscles cease the spaces are occupied by the *anterior intercostal aponeuroses*, thin shining membranes, composed of fibres having the same direction as those of the external intercostal muscles with which they are continuous externally, and covering the fore parts of the internal intercostals.

*Variety.*—The *supracostalis* (Wood) is a muscular slip occasionally seen, passing from the anterior end of the first rib downwards to the fourth, sometimes also to the second and third ribs. It has been found connected above with the deep fascia of the neck, or with the scaleni muscles.

The **internal intercostal** muscles consist of fibres which incline downwards and backwards, but are somewhat shorter and less oblique than those of the external muscles. Their attachments take place on the inner surfaces of the ribs, the upper one being situated immediately above the subcostal groove, the lower one near the upper margin of the bone. Anteriorly they reach to the sternal ends of the costal cartilages, and in the last two spaces they become continuous with the internal oblique muscle of the abdomen: posteriorly they extend as far as, or sometimes, especially in the upper spaces, slightly beyond the angles of the ribs. Where the internal intercostals are deficient behind the inner surface of each external intercostal is lined by the *posterior intercostal aponeurosis*, a membranous layer which is continuous internally with the superior costo-transverse ligament, and externally is prolonged into a thin fascia between the two intercostal muscles.

*Relations.*—The internal are separated from the external intercostal muscles at the back of the spaces by the intercostal vessels and nerves; they are lined internally by the pleura.

The **levatores costarum,** twelve on each side, arise from the tips of the transverse processes of the seventh cervical and eleven highest dorsal vertebræ. Corresponding in direction with the external intercostal muscles, into which they are continued at their outer borders, they pass downwards and outwards, spreading as they descend, and each is inserted into the outer surface of the rib belonging to the vertebra below that from which it springs, between the tubercle and angle. The levator muscles belonging to the lower ribs present some longer additional fibres which, passing over a rib, are inserted into the next one below; these fibres are sometimes distinguished as *levatores costarum longiores*.

*Relations.*—The levatores costarum lie in series superiorly with the middle and posterior scaleni, and inferiorly with the lateral lumbar intertransverse muscles.

The **subcostal** muscles (fig. 212, 10) are small, very variable bundles lying on the inner aspect of the thoracic wall, in close connection with the internal intercostals, and chiefly in the neighbourhood of the angles of the ribs. They follow the same direction as the internal intercostal muscles, but their fibres extend over one or two intercostal spaces. They are most constant on the lower ribs.

The **triangularis sterni,** a thin stratum of muscular and tendinous fibres placed within the thorax, behind the costal cartilages, arises from the deep surface of the ensiform process and lower part of the body of the sternum, and from the cartilages of two or three of the lower sternal ribs. Its fibres pass outwards and upwards in a diverging manner, the lowest being horizontal, the middle oblique, and the upper becoming more and more nearly vertical; they are inserted by separate slips into the outer parts of the cartilages of the ribs, sometimes also into the bones, from the sixth to the second inclusive, on the lower border and inner surface of each. At the lower margin the fibres are in the same plane with those of the transversalis abdominis, of which the triangularis sterni muscle is a continuation upwards.

*Relations.*—The internal mammary vessels pass between its anterior surface and the costal cartilages; the pleura is in contact with its deep surface.

*Varieties.*—The triangularis sterni is subject to much variation as to its extent and points of attachment in different bodies, and even on the opposite sides of the same body. Absence on one or both sides has been recorded.

Fig. 211.

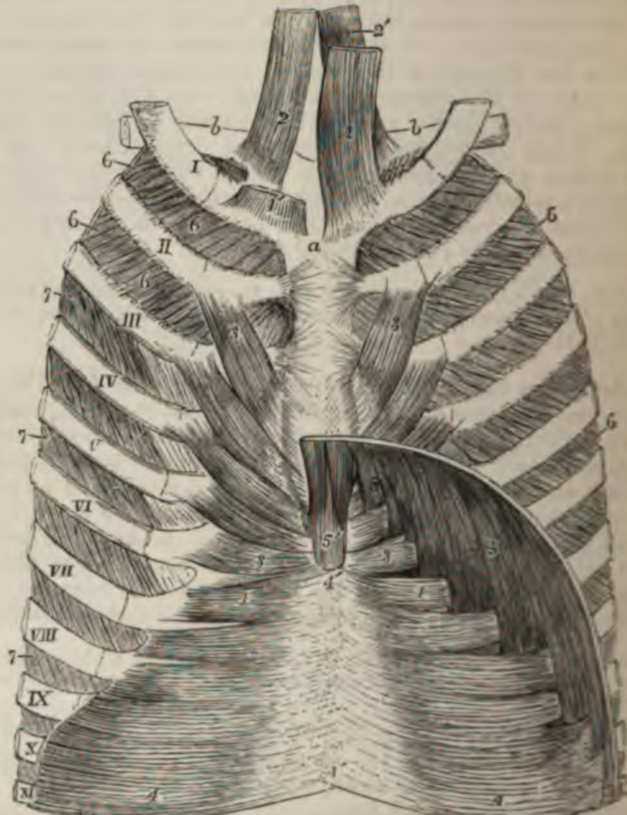


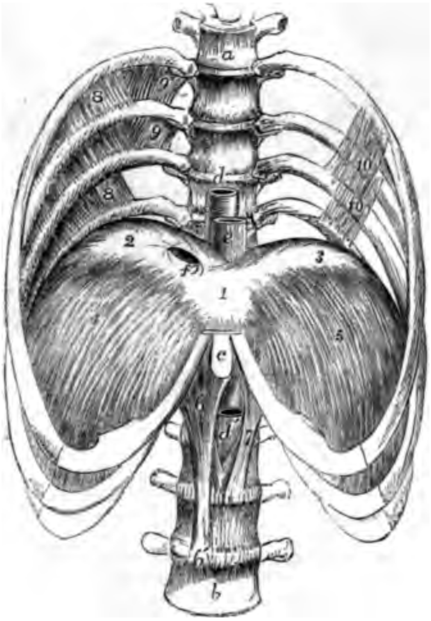
Fig. 211.—Deep muscles of the anterior wall of the thorax, seen from behind (modified from Luschka). (A. T.) ½

*a*, back of the manubrium; *b*, *b*, clavicles; I to XI, anterior parts of eleven ribs and costal cartilages; 1, 1′, sterno-thyroid muscles, that of the left side being cut short to show more fully the next muscle; 2, 2′, sterno-hyoids; 3, 3, triangularis sterni; 4, 4, upper part of transversalis abdominis, the right and left muscles meeting at 4′, 4′, the back of the linea alba; 5, attachments of the diaphragm to the lower ribs (the twelfth not represented in the figure), interdigitating with those of the transversalis; 5′, the two slips to the ensiform process; 6, 6, 6, internal intercostal muscles extending to the sternum, shown in all the spaces on the right side, but only in the highest two of the left side; at 7, 7, 7, in the lower spaces of the left side, the external intercostal muscles are seen, the internal having been removed.

## THE DIAPHRAGM.

**aphragm,** or **midriff,** forms a musculo-tendinous partition
he abdominal and thoracic cavities. It consists of muscular
:h arch upwards as they converge from the circumference of the
ׅvity to an aponeurotic tendon in the centre, and it is perforated
ious structures which pass from the thorax to the abdomen.
ng to the mode of origin and arrangement of its fibres the
ı is divided into :—a *vertebral* portion, arising posteriorly from
ır vertebræ by two thick processes or *crura,* and from two
nds on each side external to the bodies of the vertebræ, called
*ɪments;* a *costal* portion on each side, arising from the car-
the lower six ribs ; and a *sternal* portion, arising anteriorly
ɔack of the ensiform process.

Fig. 212.



ʈHE LOWER HALF OF
ɩX, WITH FOUR LUMBAR
, SHOWING THE DIA-
ROM BEFORE (modified
:hka). (A. T.) ¼

dorsal vertebra ; *b,*
ar vertebra ; *c,* ensi-
; *d, d',* the aorta pass-
its opening in the dia-
esophagus ; *f,* opening
a of the diaphragm for
vena cava ; 1, central,
d 3, left division of
tendon of the dia-
right, and 5, left
ascending from the
ıargins of the tendon ;
ıd 7, left crus ; 8,
the right side, the
th and eighth inter-
tal muscles, deficient
vertebral column,
two upper spaces the
starum and the ex-
ostal muscles 9, 9, are
, on the left side, sub-
s, in this case largely

*ɪra* or *pillars* arise by tendinous fibres, intimately connected
ınterior common ligament, from the upper three or four lumbar
ınd the interposed discs on the right side, and from the first
ıd vertebræ and corresponding discs on the left side. The
portions of the crura are continued higher internally than
, and curving forwards and inwards join in the middle line so
an arch over the front of the aorta; while inferiorly their inner
:equently meet behind that vessel, which is thus enclosed in an
ıs loop or ring. The muscular fibres of the crura, springing
tendons in thick bundles, diverge as they pass upwards to the
osterior margin of the central aponeurosis. The innermost
he two pillars decussate in front of the aortic opening, and pass

up on opposite sides of the œsophagus, for which they thus bound an elongated aperture, meeting and again decussating to some extent anteriorly as they join the tendon. In the first decussation the fasciculus derived from the right crus usually passes in front of that from the left, which is much smaller and not unfrequently is altogether wanting.

Fig. 213.

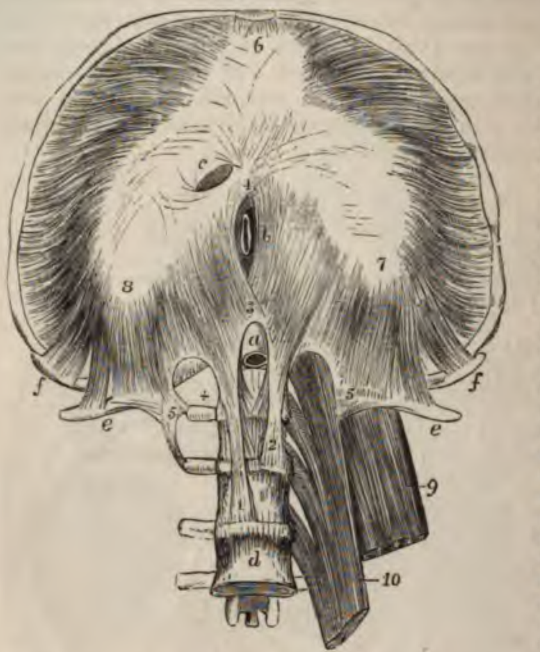


Fig. 213.—The diaphragm, from below (A. T.) ⅕

The lower ribs and sternum are drawn upwards so as to expose and stretch the lower surface of the diaphragm, and the four upper lumbar vertebræ have been exposed by the removal of all the muscles on the right side, and the dissection of the psoas magnus and quadratus lumborum on the left side. *a*, aorta, emerging from between the pillars on the first lumbar vertebra; *b*, œsophagus, in its aperture between the muscular fibres, represented too far to the right; *c*, aperture for the inferior vena cava, situated at the place of union of the middle and right divisions of the trefoil tendon; *d*, fourth lumbar vertebra; *e*, *e*, twelfth ribs; *f*, *f*, eleventh ribs; 1, tendinous part of the right crus; 2, the left; 3, tendinous arch formed by their union over the aorta, above which the decussation of the muscular fibres is seen; 4, second decussation of muscular fibres in front of the œsophageal opening; 5, on the right side, the attachment of the arched ligaments to the first and second lumbar transverse processes; from 5 to *e*, external arched ligament: +, is in the hollow of the internal arched ligament from which the psoas has been removed; 5, on the left side, external arched ligament; 6, the middle division of the trefoil tendon, from which in front pass the slips of attachment of the diaphragm to the ensiform process; 7, the left, and 8, the right divisions of the trefoil tendon; from the outer and anterior margins of these the costal slips of the muscle are seen diverging, and from the posterior border of the tendon the slips of origin proceeding from the arched ligaments and the tendinous arch of the crura; 9, part of the quadratus lumborum; 10, part of the psoas magnus.

The *internal arched ligament* (ligamentum arcuatum internum) is a fibrous band which extends from the body to the transverse process of the first lumbar vertebra, and sometimes also to that of the second, and arches over the upper part of the psoas muscle. The *external arched ligament* (ligamentum arcuatum externum) extends outwards from the transverse process of the first lumbar vertebra to the last rib, arching over the front of the quadratus lumborum: it is the upper part of the fascia covering that muscle, somewhat increased in thickness. From both arched ligaments muscular fibres take origin, and are directed upwards to the lateral portions of the posterior margin of the tendinous centre. It frequently happens that fleshy fibres spring only from the inner portion of the external arched ligament, and in that case a triangular interval is left between the vertebral and costal portions of the muscle through which the areolar tissue of the thoracic cavity becomes continuous with that of the abdomen.

The *costal* portion of the muscle consists of a series of serrated slips arising from the cartilages of the six lower ribs, and interdigitating with the attachments of the transversalis abdominis muscle (fig. 211). They sometimes arise also in part from the osseous ribs. The *sternal* portion is a narrow slip, sometimes divided into two, separated on each side from the costal portion by an interval which gives passage to the epigastric branch of the internal mammary artery, together with some lymphatics, and in which the lining membranes of the thorax and abdomen are separated only by a small quantity of loose connective tissue. The sternal fibres of the diaphragm are much the shortest; the lateral costal fibres are the longest. The fibres of the sternal and costal slips, after being united, rise in an arched and converging manner to be inserted into the anterior and external margins of the central tendon.

*The central tendon—trefoil* or *cordiform tendon*—is a strong aponeurosis, forming the central and highest part of the diaphragm. It is elongated from side to side, convex in front and concave behind, and consists of three *lobes* or *alæ*, partly separated by indentations. The right lobe is the largest; and the left, which is elongated and narrow, is the smallest of the three. The central tendon is surrounded on every side by the muscular portion of the diaphragm, the fibres of which are directly continuous with those of the tendon. The tendinous fibres cross one another, and are interwoven in various directions.

*Foramina.*—There are in the diaphragm three large perforations for the passage respectively of the aorta, the œsophagus, and the vena cava, besides some smaller holes or fissures which are less regular.—*a.* The foramen for the aorta (*hiatus aorticus*), placed in front of the vertebræ, is bounded by tendinous fibres of the crura as already described. Besides the aorta, this opening transmits the thoracic duct, and generally also the large azygos vein. *b.* The foramen for the œsophagus, higher and farther forwards than the preceding, as well as a little to its left, is separated from that opening by the decussating fibres of the crura. It is oval in form, and is generally entirely surrounded by muscular fibres; in some rare cases, however, a small part in front is formed by the margin of the central tendon. Through it pass also the pneumo-gastric nerves. *c.* The opening for the vena cava (*foramen quadratum*) is placed in the highest part of the diaphragm, in the tendinous centre at the junction of the right and middle lobes, posteriorly. Its form is somewhat quadrangular; and it is bounded by fasciculi of tendinous fibres running parallel with its sides. Besides the foregoing large foramina there are small perforations through the crura for the splanchnic nerves on both sides, and for the small azygos vein on the left side, while the large azygos vein often takes its course through the right crus. The cord of the sympathetic nerve either perforates the outer part of the crus or passes under the internal arched ligament.

*Form and Relations.*—The upper or thoracic surface of the diaphragm is highly arched. Its posterior and lateral fibres, ascending from their connection with the lower margin of the thorax, are for a considerable extent placed close to the ribs, the lungs, especially in their collapsed condition, not descending so far as the attachments of the diaphragm. The vault of the diaphragm rises higher on the right than on the left side. In the dead body it rises on the right side to the level of the junction of the fifth rib with the sternum, and on the left side only as high as the sixth. This difference is connected with the great size and firmness of the liver on the right side. It is covered superiorly by the pleuræ and the pericardium ; the fibrous layer of the latter membrane blending with the tendinous centre, as well as with the fascia covering its muscular substance. The lower surface, of a deeply concave form, is lined by the peritoneum, and has in apposition with it the liver, the stomach, the pancreas and spleen, and the kidneys.

*Varieties.*—The sternal portion of the muscle is not unfrequently wanting. As a very rare occurence a fleshy fasciculus has been seen passing from the upper surface of the diaphragm to the wall of the œsophagus (Haller, Cruveilhier).

**Nerves.**—The intercostals, levatores costarum, subcostals. and triangularis sterni are supplied by the intercostal nerves. The diaphragm is supplied by the phrenic nerves from the fourth and fifth cervical nerves, and likewise by sympathetic filaments from the plexuses round the phrenic arteries.

**Actions.—Movements of Respiration.**—The mechanical act of respiration consists of two sets of movements, viz., those of inspiration and of expiration, in which air is successively drawn into the lungs and expelled from them by the alternate increase and diminution of the thoracic cavity. The changes in the capacity of the thorax are effected by the expansion and contraction of its lateral walls, called *costal respiration*, and by the depression and elevation of the floor of the cavity, through contraction and relaxation of the diaphragm, called *diaphragmatic* or *abdominal respiration*. These two movements are normally combined in the act of respiration, but in different circumstances one of them is resorted to more than the other. Thus, abdominal respiration predominates in the male, while costal respiration is employed to a greater extent in the female.

*Inspiration.*—The study of the movements of the thoracic walls in respiration presents considerable difficulty from the complexity of these movements, and from the impossibility of perfectly imitating in the dead body the mechanical conditions under which they occur in life. On a fresh ligamentous thorax, by raising and depressing the sternum, the ribs may be moved upwards and downwards nearly parallel to one another ; the first rib moving as freely as the others. But during life several causes combine to make the first rib more fixed than those which follow ; as for example, the weight of the upper extremity, and the strain of the intercostal muscles and ribs beneath. The movements of the thoracic walls in respiration are as follows : 1st. The antero-posterior diameter is increased by a forward movement of the sternum with the attached ribs and cartilages ; the lower end of the sternum being raised and advanced, while the upper end, which in easy respiration is at rest, or nearly so, is only raised in full inspiration. 2nd. The transverse diameter of the thorax is increased by the elevation and the eversion of the ribs ; the first of these movements bringing larger costal arches to a level occupied in expiration by smaller arches above them ; and the second, by the rotation of the ribs round an axis extending from their vertebral extremities to the sternum, increases the width of their arch outwards. These movements are facilitated by the elasticity of the ribs and, to a greater extent, of the cartilages, allowing of the opening out of the angle between the two, which is rendered necessary by the resistance offered by the sternum and the weight of the upper limb to the forward and upward movement of the anterior extremities of the costal arches, while the capacity of the thorax is also increased in its inferior part by the simultaneous backward movement of the lower ribs, due to the arrangement of the costo-transverse articulations (see p. 149). 3rd. The vertical diameter of the thoracic cavity is increased by the descent of the platform of the diaphragm forming its floor ; and as the lower ribs are drawn backwards and outwards rather than raised, while the last rib may even move somewhat downwards. the depth of the hinder part of the cavity is by this means also slightly augmented. Lastly, it may be remarked, that extension of the vertebral column is an important agent in respiration, for when the column is bent forwards, the ribs are pressed gether in the concavity of the curve, and, conversely, when the column is extended, the ribs are separated.

*Action of the intercostal muscles.*—The manner in which these muscles act has een a subject of controversy from an early time, and is not yet thoroughly determined. It is now generally agreed that the external muscles are elevators of the bs, and therefore muscles of inspiration, but as to the action of the internal uscles there is still considerable difference of opinion. According to one view, efended by Haller, the external and internal layers have a common action, the ecussating fibres acting in the direction of the diagonal between them ; while according to another view, that of Hamberger, the external intercostal muscles are dmitted to be elevators, but the internal are held to be depressors of the ribs. More ecently these views have been modified by Hutchinson to the extent of admitting hat the external intercostal muscles, and the parts of the internal intercostals laced between the costal cartilages, elevate the ribs, and that the lateral portions f the internal intercostals act as depressors. This view is illustrated mechanically, nd supposed by some to be demonstrated, by means of a mechanism of rods and lastic bands imitating the conditions of the ribs. But the ribs differ from such ods in respect that they are not straight or rigid bars, and are not free at either nd, but are deeply curved, and have the greatest extent of motion in the middle f their arch ; and in the living subject the costal arches, in their elevation, both otate upon certain axes and diminish their curvature, instead of describing a simple pward and downward movement like the bars, so that it is impossible to draw ny certain conclusion from such imperfect imitations of the mechanism. The view dvocated by Haller, that the two muscles act in combination as elevators of the ibs, appears to derive support from several circumstances, among which may e particularly mentioned the deficiency of the external intercostal muscles in front and of the internal behind, in situations where both would undoubtedly ct as depressors, and the experiments of Duchenne, who found ("Physiol. des Mouvements," &c., p. 646) that the direct galvanic stimulation of the external intercostal muscle throughout the fifth space caused the lower rib to rise towards the upper, and likewise that the stimulation of the internal intercostal muscle in the intercartilaginous part of the space also caused the lower rib to rise, and who farther found that when the galvanic stimulus was so strong as to reach the ntercostal nerve, and throw the whole of the internal as well as the external intercostal muscle into action, the lower rib was still elevated. This view also s the one adopted by Henle and Luschka, the latter referring especially to the xperiments of Budge on the muscles of living animals, as proving that the internal intercostal muscles elevate the ribs (Budge, "Lehrbuch der Physiologie des Menschen," Weimar, 1860, p. 79). On the other hand, the careful and extensive series of measurements carried out by v. Ebner on the partially dissected thorax, both in the collapsed and inflated conditions, tend to confirm Hutchinson's view, indicating that, with the exception of the first two intervals, the intercostal spaces are generally widened and the fibres of the interosseous internal intercostals lengthened during inspiration (Arch. f. Anatomie, 1880, p. 185).

Apart from the action of these muscles in producing movement of the ribs, they also fulfil an important function in supporting and maintaining an equable tension in the portions of the thoracic wall corresponding to the intercostal spaces, without opposing the resistance to the movements that would be presented by a firmer although elastic structure in the same situation.

The *levatores costarum* are usually considered to have a similar action with the posterior fibres of the external intercostal muscles, and are therefore ranked among the agents of inspiration. The above-mentioned experiments of v. Ebner, however, tend to show that these muscles have very little influence upon the elevation of the ribs, but that their fibres are most contracted during extension and lateral flexion of the dorsal part of the spinal column. The *scalene* muscles also contribute, even in normal and quiet inspiration, to the support and elevation of the first and second ribs ; and it is obvious that the *serratus posticus superior* must have a similar effect on those upper ribs to which it is attached.

The *action of the diaphragm* is more easily understood than that of the intercostal muscles. By its contraction and descent its convexity is diminished, the abdominal viscera are pressed downwards, and the thorax expanded vertically. The fibres arising from the ribs, being directed nearly vertically upwards from their origins, must tend to raise those ribs, and Duchenne has shown that the contraction of the diaphragm by itself elevates and expands the upper ribs to which it is attached, but only so long as the vault of the muscle is supported by the abdominal viscera, for when they are removed it no longer has that action (*op. cit.* p. 620). The *serratus posticus inferior* and *quadratus lumborum* muscles, by opposing the diaphragm, and thus giving it a fixed point on which to descend, become assistant muscles of inspiration. The anterior fibres of the diaphragm, being directed more horizontally towards the central tendon, oppose the forward motion of the sternum; hence the sternum becomes arched in patients long subject to asthma. (Hutchinson, Article "Thorax," in Todd's "Cyclopædia of Anatomy and Physiology;" Meyer, "Physiologische Anatomie.")

In more forcible inspiration, and more especially in severe attacks of dyspnœa, there are called into play other powerful muscles, to secure the inspiratory action of which a fixed attachment must be provided by the support and elevation of the shoulder and arm; among these may be enumerated the *pectoralis minor*, the lower part of the *pectoralis major* and possibly also the lowest slips of the *serratus magnus*. Additional assistance in elevating the sternum and upper ribs is afforded by the *sterno-mastoid* and the *infrahyoid* muscles.

*Expiration.*—In normal and quiet expiration the diminution of the capacity of the chest is mainly, if not wholly, due to the return of the walls of the chest to the condition of rest, in consequence of their own elastic reaction, and of the elasticity and weight of the viscera and other parts displaced by inspiration; the lungs themselves, after distension by air, exert considerable elastic force, and no doubt the ribs and their cartilages react strongly by their elastic return from the elevated and expanded condition into which they had been thrown by the inspiratory forces. In more forcible acts of expiration, in muscular efforts of the limbs and trunk, and in efforts of expulsion from the thoracic and abdominal cavities, all the muscles which tend to depress the ribs, and those which compress the abdominal cavity, concur in powerful action to empty the lungs, to fix the trunk, and to expel the contents of the abdominal viscera. (See farther, "Action of the Abdominal Muscles.")

## MUSCLES AND FASCIÆ OF THE ABDOMEN.

FASCIÆ.—The **superficial fascia of the abdomen** is usually described as consisting of two layers. One of these, the *subcutaneous layer*, corresponds in its general features with the areolar subcutaneous tissue of other parts of the body, and contains embedded in it a very variable and often large quantity of fat. The other, or *deeper layer*, is of a denser and more membranous structure, and contains a considerable amount of yellow elastic tissue in its substance; it is only connected by loose areolar tissue to the subjacent aponeurosis of the external oblique muscle, except at the umbilicus and along the linea alba, where the attachment is more intimate, while inferiorly a fibrous and elastic expansion of considerable strength, derived from this layer, passes from the lower part of the linea alba and the symphysis pubis to the dorsum of the penis, constituting the *suspensory ligament* of that organ. These two layers are both continuous with the superficial fascia on other parts of the trunk: they can be dissected as distinct layers only on the fore part of the abdomen, and they are separated in a more marked manner in the immediate neighbourhood of the groin, where subcutaneous vessels, such as the superficial epigastric and circumflex iliac, as well as lymphatic glands, lie between them. This distinct portion of the deeper layer is known as the *fascia of Scarpa* (Struthers), and passing down freely over Poupart's ligament it ends immediately below that band by becoming blended with the fascia lata; but internally, near the external abdominal ring, it remains free and is prolonged downwards over the spermatic cord to the scrotum. The subcutaneous layer, losing its fat, is combined with the deeper layer as they both pass to the scrotum; and here the united layer acquires a reddish brown colour, and undergoes a modification in structure by becoming mingled largely with involuntary muscular fibres, constituting the *dartos tunic* of the scrotum. Some involuntary muscular fibres also exist in the altered superficial fascia which covers the penis. This covering, on leaving the scrotum posteriorly, becomes continuous with the superficial fascia of the perineum.

The parts of the superficial fascia here described have received minute attention from anatomists, by reason of their close relation to the seat of hernial tumours and other pathological conditions; the adhesion of the fascia below Poupart's ligament, and its disposition over the inguinal aperture, spermatic cord, and scrotum, while they prevent the descent upon the thigh of fluid which has been effused beneath the fascia, cause it either to spread upwards upon the abdomen or to take its course downwards into the scrotum.

The deep layer of the abdominal fascia is also interesting as corresponding with the *tunica abdominalis* of animals, a strong membrane consisting almost entirely of yellow elastic tissue, which may be well seen in the horse or ox, and which contributes to the support of the viscera.

MUSCLES.—The muscular wall of the abdomen is formed on each side for the most part by three layers of muscle, the fibres of which run in different directions; those of the superficial and middle layers being oblique, and those of the innermost layer being transverse. In front, these three layers of muscle are replaced by tendinous expansions, which meet in the middle line, giving rise to the *linea alba;* on each side of this line the fibres of the rectus muscle extend in a vertical direction between the tendinous layers, supported usually at the lower end by the pyramidalis muscle. Posteriorly, the wall is formed in part by aponeurosis, and in part by muscles of which the fibres are chiefly vertical, viz., the muscles of the back, and in front of them the quadratus lumborum.

The **obliquus externus abdominis** muscle, the strongest and most superficial of the three broad muscles of the abdomen, arises from the outer surface of the lower eight ribs, by slips arranged in a serrated series, four or five of them interdigitating with origins of the serratus magnus, and three or four with origins of the latissimus dorsi. The lower and upper digitations of the external oblique are connected with the ribs near their cartilages, the intermediate ones are attached to the ribs at some distance from their extremities; the lowest digitation generally embraces the cartilage of the twelfth rib. The fleshy fibres from the last two ribs pass down in a nearly vertical direction to be inserted into the external margin of the crest of the ilium for about the anterior half of its length; all the rest incline downwards and forwards, and terminate in tendinous fibres, which form the broad aponeurosis by which the greater part of the muscle is inserted.

The *aponeurosis* of the external oblique muscle is wider below than above, and is larger than that of either of the subjacent broad muscles. Consisting for the most part of oblique fibres, which continue the direction of the muscular fasciculi, it extends inwards towards the middle line in front, where it meets its fellow of the opposite side in the linea alba; at some distance from this line, but farther out above than below, it becomes inseparably united with the aponeurosis beneath, and forms a part of the sheath of the rectus muscle in the whole extent of the space from the ensiform process to the symphysis pubis. The upper part of the aponeurosis is connected with the pectoralis major, giving origin to the lowest fibres of that muscle. The lowest fibres of the aponeurosis are closely aggregated together, and extend across from the anterior superior spine of the ilium to the spine of the pubis, in the form of a thickened band, which is called *Poupart's ligament.* This ligament is curved with its convexity downwards owing to the attachment of the iliac portion of the fascia lata to its lower border, but the degree of curvature and the tension of the band vary with the position of the limb, being increased

Fig. 214.

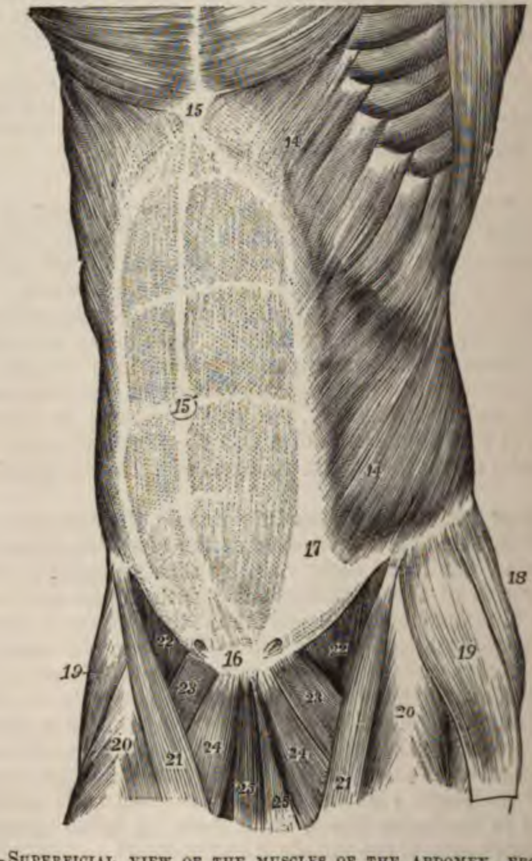


Fig. 214.—SUPERFICIAL VIEW OF THE MUSCLES OF THE ABDOMEN, FROM BEFORE AND SLIGHTLY FROM THE SIDE. (A. T.) $\frac{1}{8}$

14, 14, external oblique muscle ; 15, placed over the ensiform process at the upper end of the linea alba ; 15′, umbilicus ; 16, symphysis pubis at the lower end of the linea alba ; above 16, the pyramidales muscles are seen, showing through the abdominal aponeurosis ; from the upper 14 to 17, the linea semilunaris ; between this line and the linea alba are seen the lineæ transversæ ; above 22, the curved margin of Poupart's ligament ; on either side of 16, the external abdominal ring is indicated.

ith extension and eversion, and diminished with flexion and inversion of e thigh.

The aponeurosis is perforated by numerous small apertures for the ssage of cutaneous vessels and nerves, and near the body of the pubis y one large opening which transmits the spermatic cord in the male or he round ligament in the female. This is known as the *superficial* or *xternal abdominal ring* (*external inguinal aperture*), and is formed by the eparation of the fibres composing the lower and inner angle of the aponeurosis from the innermost part of Poupart's ligament. The direction of the opening is obliquely upwards and outwards, conformably to the direction of the principal fibres of the aponeurosis; its base is formed by the pubic crest, and its sides by the two sets of diverging fibres called the *pillars*. The upper or internal pillar is flat and straight, and is attached to the anterior surface of the symphysis pubis, decussating with the corresponding fibres of the opposite side: the lower or external pillar is in its upper part also flat and thin, but its lower part, which is formed by the inner end of Poupart's ligament, is thick and prismatic, nd curves strongly inwards to its termination at the pubic spine.

While the mesial attachment of Poupart's ligament takes place mainly nto the pubic spine, the deepest fibres of that band are sent backwards o be fixed to the innermost part of the ilio-pectineal line for a distance f about three-quarters of an inch, constituting a triangular layer which s termed *Gimbernat's ligament*, and which presents upper and lower urfaces, and a concave external margin, the latter being free and forming the inner boundary of the crural ring. Some of the fibres of Gimbernat's ligament and of the outer pillar of the ring are usually ttached only indirectly to the bone; and these are reflected upwards and nwards beneath the spermatic cord, becoming incorporated with the owest part of the front of the sheath of the rectus, and reach the middle ine where they interlace with the fibres of the opposite side. They orm a variably developed layer, placed behind the lower part of the xternal abdominal ring and its inner pillar, and known as the *triangular ascia*.

On the surface of the aponeurosis, especially in its lower part, are een slender bundles of fibres crossing transversely and binding together ts principal oblique fibres. These are the *intercolumnar fibres*, and they re most developed in the neighbourhood of the outer third of Poupart's gament, and the anterior superior iliac spine. They extend across the pper part of the external abdominal ring, closing to a greater or less tent the angular interval left between the diverging pillars, and from em a thin membrane is prolonged downwards upon the spermatic cord, own as the *intercolumnar* or *spermatic fascia*. The external abdominal ng thus acquires a somewhat oval form, and its size varies in proportion the degree of development of these fibres. In the male the opening s an average length of an inch or a little more, with a breadth of half much. In the female it is usually much smaller.

*Relations.*—The external oblique muscle is superficial with the exception of a all part at its posterior border which is overlapped by the latissimus dorsi. lies upon the internal oblique and the lower ribs with their cartilages, and e intervening intercostal muscles. The origins of the external oblique and tissimus sometimes meet at the iliac crest, but more frequently a small interval left, and the free portion of bone forms the base of a triangular space between e two muscles, in which a hernia (lumbar hernia) has been seen to protrude.

*Varieties.*—The external oblique varies chiefly in the number of its attachments to the ribs. Absence of the highest or lowest digitation is not uncommon; on the other hand, one or more slips may be doubled, most frequently those from the eighth and ninth ribs; or an additional slip may arise from the lumbar aponeurosis below the last rib. Besides the connection with the pectoralis major, some fibres are occasionally continued into the serratus magnus. The muscle has also been found double, the deeper portion passing from the ninth, tenth and eleventh ribs to the crest of the ilium (Macalister).

The **obliquus internus abdominis** muscle, placed under cover of the external oblique, arises by fleshy fibres from the external half or two-thirds of the deep surface of Poupart's ligament; by short tendinous fibres from the iliac crest for two-thirds of its length; and by some fleshy fibres again from the posterior aponeurosis of the transversalis muscle (lumbar fascia), in the angle between the crest of the ilium and the outer margin of the erector spinæ muscle. From those attachments the fibres, spreading over the side of the abdomen, pass to be inserted as follows: the most posterior fibres pass upwards and forwards to the lower margins of the cartilages of the last three ribs, where they are inserted in the same plane with the internal intercostal muscles; those arising from the anterior part of the

Fig. 215.

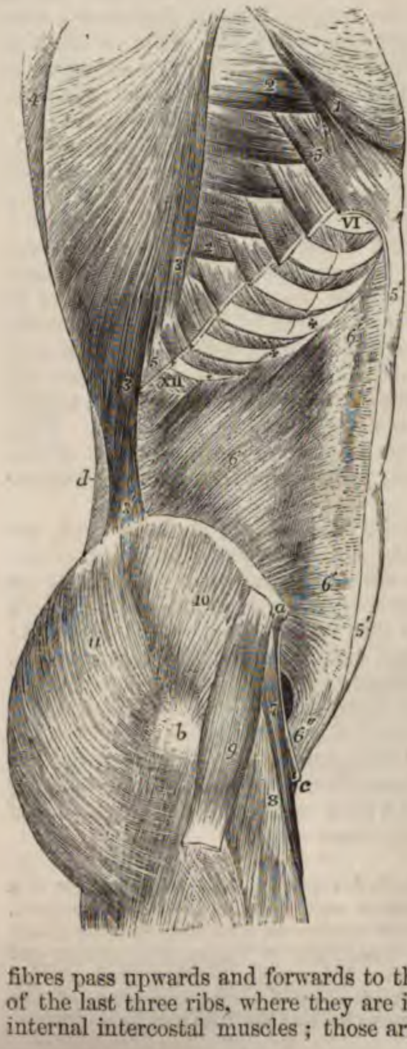


Fig. 215.—Lateral view of the muscles of the abdomen, the internal oblique muscle having been exposed by the removal of the external oblique (modified from Henle). (A. T.) $\frac{1}{4}$

*a*, anterior superior iliac spine; *b*, great trochanter; *c*, pubic spine; *d*, posterior layer of the lumbar fascia; VI and XII, sixth and twelfth ribs; 1, lower part of the pectoralis major, where it is attached to the aponeurosis of the external oblique; 2, 2, lower digitations of the serratus magnus; 3, 3, costal attachments of the latissimus dorsi; 3′, its iliac attachment; 4, trapezius; 5, 5, divided attachments of the external oblique, left in connection with the ribs; 5′, 5′, aponeurosis of the external oblique divided in front of the rectus, where it joins the sheath; 6, internal oblique at its middle; 6′, 6′, line where its aponeurosis divides to form the sheath of the rectus; + + + XII, its attachment to the lowest ribs; 6″, conjoined tendon; 7, sartorius; 8, rectus femoris; 9, tensor vaginæ femoris; 10, gluteus medius; 11, gluteus maximus.

iliac crest pass forwards, the upper more obliquely and the succeeding ones more horizontally, to end in an aponeurosis on the front of the abdomen; those from the anterior superior spine run horizontally to the same aponeurosis; while the fibres from Poupart's ligament, usually paler than the rest, arch downwards and inwards over the spermatic cord, or the round ligament of the uterus, and end in tendinous fibres common to them and the lower part of the transversalis muscle, thus forming the structure known as the *conjoined tendon* of these muscles; through the medium of this tendon they are attached to the front of the pubis, and to the inner part of the ilio-pectineal line, behind Gimbernat's ligament. The spermatic cord, or round ligament, passes under the arched lower borders of the transversalis and internal oblique muscles on its way from the internal to the external abdominal ring.

The *aponeurosis* of the internal oblique may be regarded as the expanded tendon of the muscle continued forwards and inwards: it extends from the margin of the thorax to the pubis, and is wider at the upper than at the lower end. At the outer border of the rectus muscle the aponeurosis divides into two layers, one passing before, the other behind that muscle; and the two reunite at its inner border in the linea alba, so as to enclose it in a sheath. The anterior layer, as already mentioned, becomes inseparably united with the aponeurosis of the external oblique muscle, and the posterior layer is similarly incorporated with that of the transversalis. The upper border of the posterior lamina is attached to the margins of the seventh and eighth rib-cartilages, as well as to the ensiform process. This division of the aponeurosis into two layers stops short a little above half-way between the umbilicus and the pubis, the aponeurosis below that level remaining undivided, and along with that of the transversalis muscle to which it is united, passing wholly in front of the rectus. The deficiency thus resulting in the posterior wall of the sheath of the rectus is marked superiorly by a more or less well defined lunated edge, the concavity of which looks downwards towards the pubis—the *semilunar fold of Douglas.*

*Relations.*—The internal oblique muscle is almost entirely covered by the external oblique. The hindmost part of the muscle, arising from the lumbar fascia, is under cover of the latissimus dorsi, and a small part is frequently exposed between the latissimus and the external oblique, when those muscles fail to meet at their iliac origins.

*Varieties.*—A fibrous band or inscription is not uncommonly seen in the upper part of this muscle, prolonged forwards from the point of the tenth or eleventh rib, and a slender cartilaginous slip, separate from that of the rib, has been seen lying in this inscription. An additional slip of insertion, into the ninth costal cartilage, is occasionally present.

The **cremaster**, a muscle peculiar to the male, consists of fibres lying in series with those of the lower border of the internal oblique muscle. It has an external and an internal attachment. The external attachment is to the inner part of Poupart's ligament, and there its fibres are continuous with those of the internal oblique muscle: the internal attachment, smaller and less constant, is by means of a tendinous band to the spine and crest of the pubis, close to the insertion of the internal oblique muscle. The superior fibres of the muscle extend between these attachments in a series of successively longer loops, descending in front of the spermatic cord, a few of them reaching as low as the level of the testicle; the remaining fibres, the greater number of which descend from the outer attachment, and only a few from the in spread out inferiorly and are embedded in the substance of a fi termed *cremasteric*, which adheres to the fascia propria of the test Sometimes the only fibres developed are a bundle descending from outer attachment.

In the female there may be almost constantly detected a few fibres cending on the round ligament of the uterus, which correspond with the mentioned fibres of the cremaster muscle of the male.

Fig. 216.

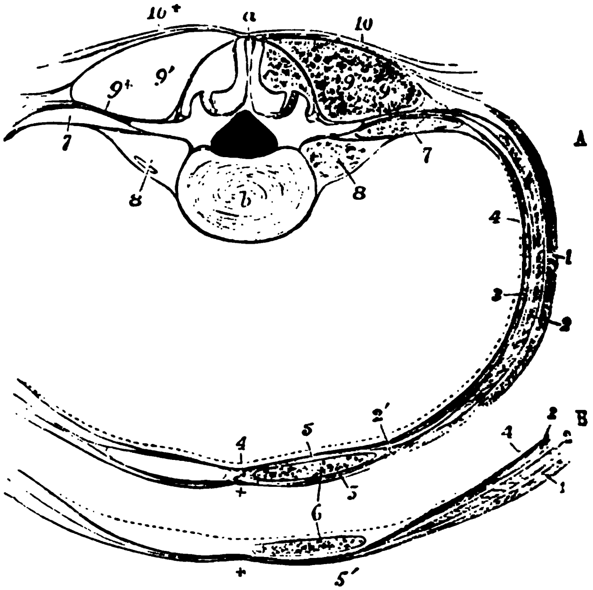


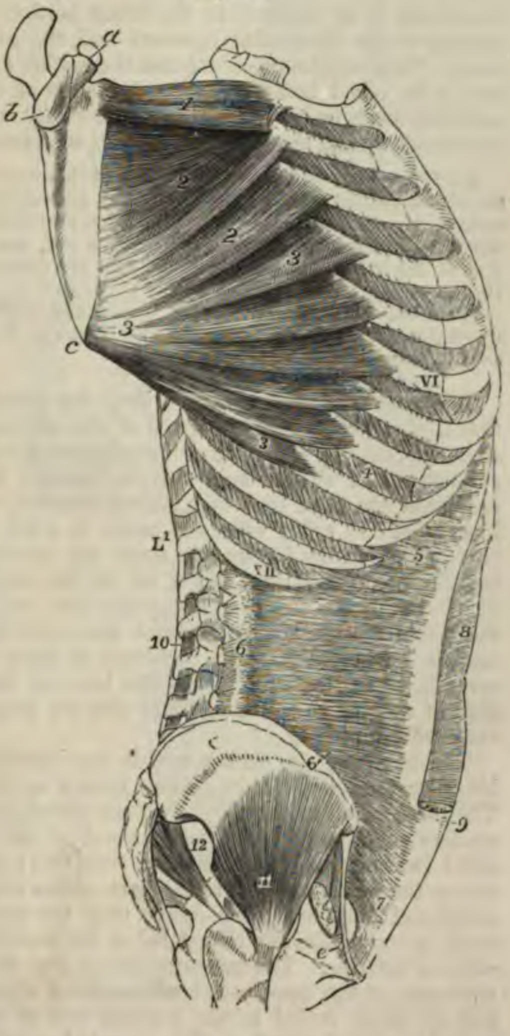
Fig. 216.—DIAGRAM OF A TRANSVERSE SECTION OF THE WALL OF THE ABDOM SHOW THE CONNECTIONS OF THE LUMBAR FASCIA, AND THE SHEATH OF THE MUSCLE. (A. T.) $\frac{1}{3}$

A, at the level of the third lumbar vertebra; B, the fore part, at a few inche the pubis.

*a*, spinous process, *b*, body of the third lumbar vertebra; 1, external oblique 2, internal oblique; 3, transversalis; 4, a dotted line to mark the position transversalis fascia; 5, 5, in A, anterior and posterior parts of the sheath of the formed by the aponeurosis of the internal oblique splitting at the outer edge muscle, 2′; 6, rectus abdominis; 7, anterior layer of the lumbar fascia, passing i of the quadratus lumborum to the anterior surface of the transverse process; 8, psoas and parvus muscles; 9, 9′, erectores spinæ muscles; 9+, middle layer of the fascia (posterior aponeurosis of the transversalis) passing to the extremity transverse process; 10, 10+, posterior layer of the lumbar fascia, connected w latissimus dorsi and serratus posticus inferior: in A, at the sheath of the rec aponeurosis of the external oblique is seen to unite in front with the sheath, wh of the transversalis is seen uniting with it behind: in B, the section is taken be semilunar fold of Douglas, and all the tendons pass in front of the rectus at 5′; near this, and in a similar place in A, marks the middle line, and the place of th of the several aponeuroses in the linea alba.

The **transversalis abdominis** muscle, subjacent to the in oblique, arises from the inner surface of the cartilages of the six *ribs* by fleshy slips which interdigitate with the costal attachments aphragm (fig. 211, p. 316) ; from the transverse processes of the lumbar rtebræ by a strong posterior aponeurosis ; from the inner margin of the est of the ilium in the anterior two-thirds of its extent ; and from the ter third of Poupart's ligament. The greater part of the fibres have a orizontal direction, and extend forwards to a broad aponeurosis in front ; he lowest fibres curve downwards like those of the internal oblique, with hich they are frequently closely united, and are inserted into the front he pubis and into ilio-pectineal line, ugh the medium he conjoined ten- already described common to this cle and the inter- oblique.

Fig. 217.



ig. 217.—Lateral view of the trunk, showing the serratus magnus and transversalis abdominis muscles. (A. T.) $\frac{1}{5}$

For the explanation of he references in the upper art of the figure see the escription of fig. 160, p. 01.

c, placed on the pubis, oints to the inser- on of Gimbernat's liga- ent ; VI, XII, sixth d twelfth ribs ; L¹, first mbar vertebra ; 5, costal igins of the transversalis dominis ; 6, origin of e muscle from the trans- rse processes of the lum- r vertebræ by the lum- r aponeurosis ; 6′, part ing from the crest of ilium ; 7, lower por- rising from the outer t of Poupart's ligament; sheath of the rectus cle opened in its upper by removing the eurroses of the oblique cles ; 9, the same in ower part left entire he place where the ons pass entirely in of the rectus muscle ; nterspinales muscles ; luteus minimus ; 12, ormis.

he *anterior aponeurosis* of the transversalis muscle commences in the ter part of its extent at the distance of about an inch from the r border of the rectus muscle ; but at its upper extremity it is much ower, and there the muscular fibres of opposite sides approach [illegible] is a white fibrous structure extending perpendicularly [illegible] from the ensiform process to the pubis. This tendinous [illegible] by the union of the aponeuroses of the two oblique [illegible] muscles, the tendinous fibres being continued in a [illegible] from one side to the other. Some longitudinal [illegible] towards its lower end. It is broader superiorly [illegible] a little below the middle it is widened out into a [illegible] the centre of which is situated the cicatrix of the [illegible]

[illegible] is a curved linear depression on each side of the [illegible] abdomen, situated along the outer border of the rectus [illegible] as a white line on the surface of the aponeurosis [illegible]. It corresponds to a narrow portion of the [illegible] internal oblique, between its division to form the [illegible] internally, and the termination of the fleshy fibres [illegible] externally. The *lineæ transversæ* are cross lines, corre[illegible] by, the tendinous intersections of the rectus.

[illegible] **quadratus lumborum** is an irregularly quadrilateral muscle, [illegible] than above, placed between the last rib and the [illegible] the vertebral column. It arises below by fleshy and [illegible] from the ilio-lumbar ligament and from the iliac crest [illegible] behind and external to the attachment of that [illegible] the inner side from the transverse processes of two, three [illegible] vertebræ, by tendinous and fleshy slips, the fibres of [illegible] the anterior surface of the muscle. It is inserted into [illegible] the last rib for about half its length, and into the [illegible] of the upper four lumbar vertebræ, by tendinous slips [illegible] slips arising from those processes.

[illegible]—The quadratus lumborum is contained in a sheath formed by the [illegible] layers of the lumbar fascia. Its anterior surface is over[illegible] and upon it rests the kidney, while the ascending or de[illegible] in front of its outer border. The inner border is intimately [illegible] lateral intertransverse muscles.

[illegible] number of the points of insertion of this muscle to the ver[illegible] extent of its connection with the last rib, vary in different [illegible] sometimes attached to the body or transverse process of the last [illegible]

**Nerves.**—[illegible] muscles are supplied generally by the lower inter[illegible] internal oblique and transversalis receive also branches from [illegible] ilio-inguinal nerves, and the cremaster is supplied by the [illegible] genito-crural nerve. The quadratus lumborum receives [illegible] the last dorsal and the upper lumbar nerves.

**Actions.**—[illegible] muscles not only form a great part of the wall to [illegible] abdominal viscera, but by their contraction are capable [illegible] these viscera, on the thorax, and on the vertebral [illegible] and thorax are fixed, the abdominal muscles constrict [illegible] the viscera, particularly if the diaphragm be fixed at [illegible] of the glottis, as occurs in vomiting and in the [illegible] fæces, and the urine.

[illegible] fixed, these muscles raise the diaphragm by pressing [illegible] down the ribs, and contract the base of the thorax. [illegible]; but if the vertebral column be not fixed, the [illegible] forwards, when the muscles of both sides act, or [illegible] on one side only, or rotated when the external [illegible] opposite internal oblique act in combination.

If the thorax be fixed, the abdominal muscles may be made to act on the pelvis; thus, in the action of climbing, the trunk and arms being elevated and fixed, the pelvis is drawn upwards, either directly or to one side, as a preparatory step to the elevation of the lower limbs.

LINING FASCIA OF THE ABDOMEN.—On the inner surface of the wall of the abdomen is a membranous structure which lines the visceral aspect of the deepest stratum of muscles : it is divisible into two principal parts, the transversalis fascia and iliac fascia.

The **transversalis fascia** is named from its position on the deep surface of the transversalis muscle. It is strongest in the lower part of the abdomen, where the muscular and tendinous support is somewhat weaker. Followed upwards from this situation, it becomes gradually lighter, and beyond the margin of the ribs it is continued into a thin areolar layer on the under surface of the diaphragm. Along the inner margin of the iliac crest, between the iliacus and transversalis muscles, the fascia is attached to the periosteum. For about two inches inwards from the anterior superior iliac spine, it is closely connected with the back of Poupart's ligament, and is there directly continuous with the iliac fascia. Internal to the middle of Poupart's ligament, the external iliac artery and vein, as they pass out into the thigh, intervene between the transversalis fascia and the iliac fascia, and from this point to the edge of Gimbernat's ligament the transversalis fascia is prolonged downwards under Poupart's ligament, and over the vessels, forming the anterior portion of the funnel-shaped crural sheath. As this prolongation of the fascia passes under Poupart's ligament it is strenghtened by a dense band of fibres, constituting the *deep crural arch*, which curves over the vessels, and is inserted into the pubic spine and the ilio-pectineal line behind the conjoined tendon of the transversalis and internal oblique muscles. It includes beneath it, internal to the vessels, a space between Gimbernat's ligament and the vein, sufficiently large to admit the point of the little finger ; this is called the *crural ring*, and is the space through which a femoral hernia descends. About mid-way between the anterior superior iliac spine and the symphysis pubis, and about half an inch above Poupart's ligament, the spermatic cord in the male, or the round ligament in the female, pierces the transversalis fascia. The opening thus made is called the *internal* or *deep abdominal ring* (*internal inguinal aperture*); the fascia above and internal to it is thin, but below and external to it is firm and thick, and the lower boundary of the opening is formed by a distinct crescentic edge, over which the cord or round ligament passes : from the margin of the opening a delicate funnel-shaped covering, the *infundibuliform fascia*, is prolonged downwards on the emerging structures, and this forms in cases of oblique hernia one of the coverings of the tumour.

The **iliac fascia**, stronger than the transversalis fascia, lines the back part of the abdominal cavity, and covers the ilio-psoas muscle. The densest portion of its fibres is stretched transversely from the iliac crest, over the iliacus and psoas, to the brim of the pelvis, where it is attached to the iliac portion of the ilio-pectineal line. A thinner part of the membrane is continued upwards on the surface of the psoas, along the inner border of which it is attached to the sacrum, to the intervertebral discs and the neighbouring margins of the lumbar vertebræ as well as to the tendinous arches over the lumbar vessels (p. 240). Externally, it joins the anterior layer of the lumbar fascia, and above, it

The *linea alba* is a white fibrous structure extending perpendicularly in the middle line from the ensiform process to the pubis. This tendinous band is formed by the union of the aponeuroses of the two oblique and the transverse muscles, the tendinous fibres being continued in a decussating manner from one side to the other. Some longitudinal fibres are distinguishable towards its lower end. It is broader superiorly than inferiorly, and a little below the middle it is widened out into a circular flat space, in the centre of which is situated the cicatrix of the *umbilicus*.

The *linea semilunaris* is a curved linear depression on each side of the front of the abdomen, situated along the outer border of the rectus muscle, and appearing as a white line on the surface of the aponeurosis of the external oblique. It corresponds to a narrow portion of the aponeurosis of the internal oblique, between its division to form the sheath of the rectus internally, and the termination of the fleshy fibres of the muscle externally. The *lineæ transversæ* are cross lines, corresponding to, and produced by, the tendinous intersections of the rectus.

The **quadratus lumborum** is an irregularly quadrilateral muscle, somewhat broader below than above, placed between the last rib and the pelvis, close to the vertebral column. It arises below by fleshy and tendinous fibres from the ilio-lumbar ligament and from the iliac crest for about two inches, behind and external to the attachment of that ligament, and on the inner side from the transverse processes of two, three or four lumbar vertebræ, by tendinous and fleshy slips, the fibres of which ascend on the anterior surface of the muscle. It is inserted into the lower border of the last rib for about half its length, and into the transverse processes of the upper four lumbar vertebræ, by tendinous slips placed behind the slips arising from those processes.

*Relations.*—The quadratus lumborum is contained in a sheath formed by the anterior and middle layers of the lumbar fascia. Its anterior surface is overlapped by the psoas, and upon it rests the kidney, while the ascending or descending colon lies in front of its outer border. The inner border is intimately connected with the lateral intertransverse muscles.

*Varieties.*—The number of the points of insertion of this muscle to the vertebræ, and the extent of its connection with the last rib, vary in different instances. It is sometimes attached to the body or transverse process of the last dorsal vertebra.

**Nerves.**—The abdominal muscles are supplied generally by the lower intercostal nerves. The internal oblique and transversalis receive also branches from the ilio-hypogastric and ilio-inguinal nerves, and the cremaster is supplied by the genital branch of the genito-crural nerve. The quadratus lumborum receives small branches from the last dorsal and the upper lumbar nerves.

**Actions.**—The abdominal muscles not only form a great part of the wall to enclose and support the abdominal viscera, but by their contraction are capable of acting successively on those viscera, on the thorax, and on the vertebral column. When the pelvis and thorax are fixed, the abdominal muscles constrict the cavity and compress the viscera, particularly if the diaphragm be fixed at the same time by the closure of the glottis, as occurs in vomiting and in the expulsion of the fœtus, the fæces, and the urine.

If the vertebral column be fixed, these muscles raise the diaphragm by pressing on the abdominal viscera, draw down the ribs, and contract the base of the thorax, and so contribute to expiration; but if the vertebral column be not fixed, the thorax will be bent directly forwards, when the muscles of both sides act, or inclined laterally when they act on one side only, or rotated when the external oblique of one side and the opposite internal oblique act in combination.

ax be fixed, the abdominal muscles may be made to act on the in the action of climbing, the trunk and arms being elevated and is is drawn upwards, either directly or to one side, as a preparatory vation of the lower limbs.

SCIA OF THE ABDOMEN.—On the inner surface of the wall of i is a membranous structure which lines the visceral aspect t stratum of muscles : it is divisible into two principal parts, salis fascia and iliac fascia.

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**s fascia**, stronger than the transversalis fascia, lines the f the abdominal cavity, and covers the ilio-psoas muscle. portion of its fibres is stretched transversely from the iliac he iliacus and psoas, to the brim of the pelvis, where it is the iliac portion of the ilio-pectineal line. A thinner part rane is continued upwards on the surface of the psoas, along order of which it is attached to the sacrum, to the inter- ces and the neighbouring margins of the lumbar vertebræ as he tendinous arches over the lumbar vessels (p. 240). Ex- joins the anterior layer of the lumbar fascia, and abo becomes blended with the internal arched ligament of the diaphragm. Inferiorly the iliac fascia is prolonged downwards, covering the conjoined muscle, a short distance into the thigh, being placed behind the femoral artery and vein, and forming the hinder portion of the crural sheath. On the outer side of the vessels, the fascia is closely united as it descends with the lower border of the transversalis fascia and Poupart's ligament, and it ends by blending with the fascia lata forming the upper part of the sheath of the sartorius. Internally this part of the fascia becomes directly continuous with the pubic portion of the fascia lata (see p. 232), while from the junction of the two a short but strong intermuscular septum is sent backwards between the psoas and pectineus muscles to be attached to the ilio-pectineal eminence and the capsule of the hip-joint.

In cases where the psoas parvus is present the iliac fascia is thickened above the ilio-pectineal eminence by the incorporation of the tendon of this muscle as it expands to its insertion.

At the back part of the abdomen there is also a thin membrane covering the quadratus lumborum muscle and forming the **anterior layer of the lumbar fascia.** It is attached at the inner border of the quadratus to the front of the transverse processes of the lumbar vertebræ, while along the outer border of that muscle it becomes united with the middle layer of the fascia. Superiorly it forms the external arched ligament of the diaphragm already described, and inferiorly it is attached to the ilio-lumbar ligament and the crest of the ilium.

The **middle layer of the lumbar fascia,** much stronger than the anterior, and placed between the erector spinæ and quadratus lumborum, is formed by the posterior aponeurosis of the transversalis muscle, in connection with which it has already been described (p. 330).

## MUSCLES AND FASCIÆ OF THE PERINEUM AND PELVIS.

Fasciæ of the Perineum—**Superficial Fascia.**—In the posterior half of the perineum the subcutaneous fat is continued deeply into the ischio-rectal fossa, the pyramidal space intervening between the obturator fascia and the levator ani muscle. In the anterior half of the perineum, beneath the subcutaneous fat, is placed a special layer of fascia, continuous with the dartos, the proper *superficial perineal fascia,* sometimes called *fascia of Colles.* This fascia is bound down on each side to the margin of the rami of the pubis and ischium as far back as the ischial tuberosity; posteriorly, along a line from the ischial tuberosity to the central point of the perineum, it turns round the posterior margin of the transversus perinei muscle to join the deep perineal fascia, to be presently described. From its deep surface likewise, an incomplete septum in the middle line passes upwards towards the urethra and is continued forwards into the scrotum. It thus happens that air blown in beneath the proper perineal fascia on one side passes forwards and distends the scrotum to a certain extent on that side; it may then penetrate to the other side also, and if injected with sufficient force may reach the front of the abdomen, and travel upwards beneath the superficial fascia; but it neither passes backwards to the posterior half of the perineum nor downwards upon the thighs. The same course is followed by urine or matter extravasated beneath the proper perineal fascia.

The **deep perineal** or **subpubic fascia, triangular ligament of the urethra,** is stretched across the subpubic arch on the deep surface of the crura of the penis and the bulb of the urethra. It consists of two distinct layers of strong fibrous membrane, separated by intervening structures. The *inferior* or *anterior layer*, extending backwards in the middle line to the central point of the perineum, is attached on each side to the rami of the pubis and ischium, while posteriorly its base becomes connected with the superior layer, and with the recurved margin of the superficial perineal fascia. Anteriorly it is continued into the angle between the crura of the penis, and at a deeper level a short but strong fibrous band (transverse ligament of the pelvis, Henle) stretches across the subpubic angle near its apex, bounding with the subpubic ligament an oval aperture, through which the dorsal vein of the penis is transmitted. About an inch from the symphysis this layer is perforated by the urethra, immediately before its entrance into the bulb, and the latter structure is intimately adherent to, and receives a superficial expansion from, the under surface of the membrane. Farther forwards it is also pierced by the pudic artery and the dorsal nerve of the penis on each side. Between the two layers of the deep perineal

Fig. 219.

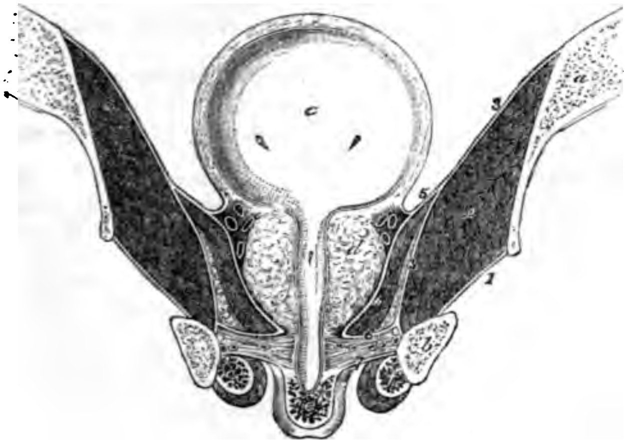


Fig. 219.—FRONTAL SECTION OF THE PELVIS IN THE SITUATION INDICATED BY THE LINE A, A′, IN FIG. 220, SHOWING THE DISPOSITION OF THE PELVIC FASCIA AND TRIANGULAR LIGAMENT OF THE URETHRA (SEMIDIAGRAMATIC). (G.D.T.) ½

*a*, section of the hip-bone passing though the centre of the acetabulum ; *b*, section of the ramus of the ischium ; *c*, bladder, from which the urethra is continued downwards ; *d*, prostate gland ; *e*, corpus spongiosum urethræ, covered by the bulbo-cavernosi muscles ; *f*, crus penis, covered by the ischio-cavernosus muscle ; 1, obturator membrane ; 2, obturator internus muscle ; 3, 3, obturator fascia ; 4, levator ani muscle ; 5, recto-vesical fascia, dividing into an ascending layer attached to the bladder, and a descending layer forming the sheath of the prostate : between the fascia and the prostate are the veins of the prostatic plexus ; 6, superior, and 7, inferior layer of the triangular ligament of the urethra ; 8, constrictor urethræ muscle, embedded in which, close to the ischium, are the pudic vessels and the dorsal nerve of the penis.

In order to show more clearly the relations of the parts, the urethra is represented as being laid open through the whole of the prostatic and membranous, and the commencement of the spongy portions ; whereas the lower half of the prostatic portion is naturally a little behind the plane of the section.

fascia are placed the membranous portion of the urethra, the constrictor muscle of the urethra, and Cowper's glands, together with the pudic arteries and the arteries of the bulb, and the dorsal vein and nerves of the penis. The *superior* or *posterior layer* consists of right and left lateral halves, which are separated in the middle line by the urethra close to the neck of the prostate, where they are continued into the sheath of that gland derived from the recto-vesical portion of the pelvic fascia, whilst laterally they join on each side the obturator portion of the pelvic fascia close to its attachment to the pubic and ischial rami. This layer of fascia is superficial to the anterior fibres of the levator ani muscle, which lie between it and the recto-vesical fascia, and it is connected with a thin web of areolar tissue which extends backwards on the surface of the levator ani muscle, and is distinguished as the *anal fascia.*

In the female the deep perineal fascia is divided in the middle by the vagina.

FASCIÆ OF THE PELVIS.—The **pelvic fascia** is a complicated structure lining the muscles within the cavity of the pelvis and supporting the pelvic viscera. It consists of two principal parts, which are known as the *obturator fascia* and the *recto-vesical fascia.*

The **obturator fascia**, a distinct piece on each side of the pelvis, may be regarded as the special fascia of the obturator internus muscle, the inner surface of which it covers, and around which it is fixed to the bone. It is attached above for a short distance to the iliac portion of the iliopectineal line; in front, to the body of the pubis along an oblique line extending from the upper and inner part of the thyroid foramen to a little below the symphysis; behind, to the anterior margin of the great sciatic notch, as well as to the great sacro-sciatic ligament; and below it joins the falciform process of that ligament by means of which it is connected to the ischial and pubic rami. At the upper end of the thyroid foramen its attachment to the bone is interrupted and the fascia joins the upper edge of the obturator membrane, forming an arch over the border of the muscle, and bounding below the short canal by which the obturator vessels and nerve issue. The inner surface of this fascia in its upper part looks into the pelvic cavity and is lined by peritoneum; in its lower part it looks into the perineal space, forming the outer boundary of the ischio-rectal fossa, and in this part of the fascia the internal pudic vessels and nerve are embedded in a sheath as they course to the front of the perineum.

The *fascia of the pyriformis* is a thin and unimportant layer, which is continued backwards from the obturator fascia to the sacrum, passing in front of the pyriformis muscle and the nerves of the sacral plexus, and being perforated by the branches of the internal iliac vessels which leave the pelvis by the great sacro-sciatic foramen.

The **recto-vesical fascia** is attached anteriorly to the back of the pubis above the obturator fascia, from which it is here separated by the origin of the levator ani, the three being, however, generally closely adherent near the bone; laterally it springs from the obturator fascia along a curved line passing from the upper part of the obturator foramen to the ischial spine; and posteriorly it becomes continuous with the lower part of the fascia of the pyriformis. From these attachments the fascia is directed downwards and inwards, in contact with the upper surface of the levator ani muscle, to the prostate gland, to the bladder, and to the rectum, and being farther continuous from side to side across the middle in front of the bladder and between the bladder and the rectum, thus forms a fibrous partition which completely separates the vic cavity above from the perineal space below. Certain parts of fascia, generally not very well defined, however, are referred to as ments of the viscera with which they are connected. The best rked of these are the *anterior true ligaments of the bladder* or *pubo-atic ligaments*, a narrow but strong band on each side, consisting in t part of involuntary muscular fibres, and passing from the lower

Fig. 220.

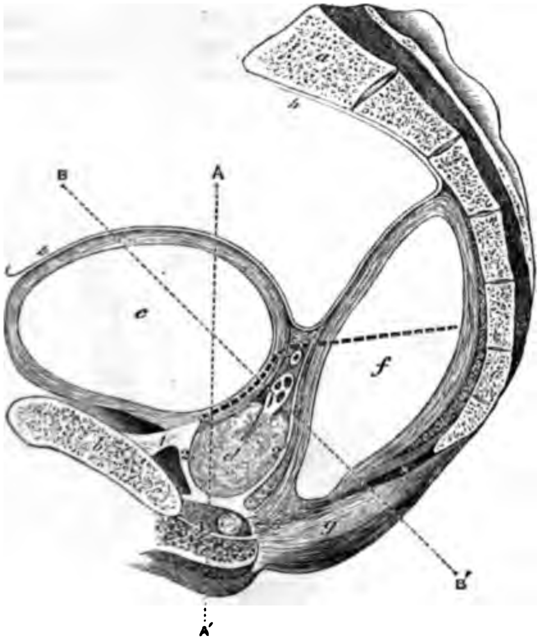


Fig. 220.—Diagram of a sagittal section of the pelvis, a little to the left of the mesial plane, to show the arrangement of the pelvic fascia, &c. (G.D.T.) ½

a, a, section of sacrum and coccyx; *b*, section of pubis; *c*, bladder; *d*, prostate gland, above which are the vesicula seminalis and vas deferens cut obliquely; *e*, corpus spongiosum urethræ, covered by the bulbo-cavernosus muscle; *f*, rectum; *g*, external sphincter; ×, levator ani; 1, anterior true ligament of bladder; 2, 2′, sheath of prostate, continuous below with the upper layer of the triangular ligament of the urethra; the hinder part of the sheath is continued upwards between the vesiculæ seminales and the rectum; 3, inferior layer of the triangular ligament, between which and the superior layer are seen in section the constrictor urethræ muscle and Cowper's gland; 4, 4, peritoneum.

The thick dotted line indicates the level at which, to the left of the section, the ascending layer of the recto-vesical fascia is attached to the bladder and rectum. The thinner dotted lines A, A′, and B, B′, represent the situation of the sections shown in figs. 219 and 221.

part of the pubis to the anterior surface of the prostate and the neck of the bladder. Between the two ligaments the fascia is thin and depressed, forming a small pouch which is occupied by some loose fat and areolar tissue. On the outer side of the anterior ligament, the part of the fascia

which descends to the side of the bladder and prostate is known as t
*lateral true ligament of the bladder;* and farther back, the part join
the side of the rectum has been called the *ligament of the rect*
(Ellis). There is also seen on the upper surface of the recto-vesical fas
another thickened band, which springs from the pubis in common wi
the anterior true ligament of the bladder, and passes backwards and ou
wards to the ischial spine, thus strengthening the floor of the pel
cavity, and assisting materially in the support of the bladder. This
the so-called *white line of the pelvic fascia,* and in its posterior part
corresponds to the place of origin of the recto-vesical fascia from t
obturator fascia.

At its connection with the viscera, the recto-vesical fascia has t
following arrangement. The anterior part of the fascia meets the si
of the bladder along the line of its junction with the prostate, and the

Fig. 221.

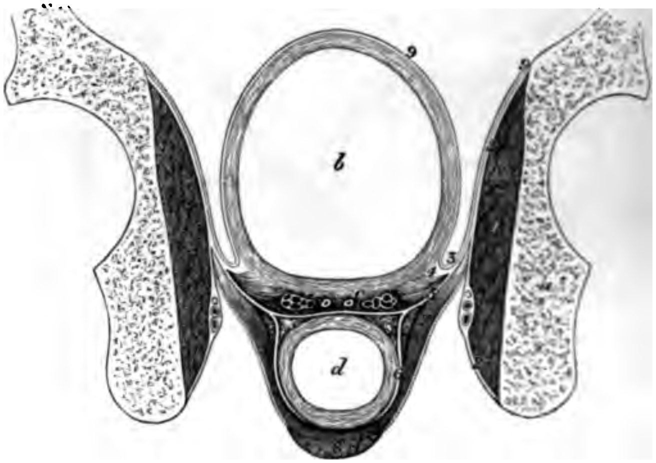


Fig. 221.—DIAGRAM OF AN OBLIQUE SECTION OF THE PELVIS IN THE SITUATION INDIC
BY THE LINE B, B′, IN FIG. 220. (G.D.T.) ½

*a*, section of hip-bone, passing behind the centre of the acetabulum; *b*, bladder
vesicula seminalis and vas deferens of the right side; *d*, rectum: 1, obturator inte
muscle; 2, 2, obturator fascia, in the lower part of which the pudic vessels and nerve
contained in a sheath; 3, recto-vesical fascia; 4, its upper layer attached to the blad
5, its lower layer passing across in front of the rectum, and continuous with, 6,
lateral part of the investment of the rectum; 7, levator ani, the dotted line on
under surface indicates the position of the anal fascia; 8, external sphincter; 9
peritoneum.

divides into two layers. The upper of these is short and is refle
upwards, soon becoming closely united with the muscular coat of
bladder: the lower is stronger and more extensive, and is contin
downwards, forming the sheath of the prostate, which at the ape
that gland is continued into the superior layer of the deep perineal fa
(triangular ligament of the urethra). In the angle between the
layers, and between the sheath and the substance of the prostate, are c
tained the large veins of the prostatic plexus, but these structures ar

ınited by dense connective tissue that the prostatic sheath can dissected off the gland with difficulty. Behind and above the , the prolongation of the upper layer is attached to the base of lder immediately outside the line of the vesiculæ seminales, which excluded, together with the intervening portion of the base of lder, from the proper pelvic cavity; while the inferior layer, con- with the posterior part of the prostatic sheath, extends across the bladder and rectum, on the one hand binding the vesiculæ es and vasa deferentia to the base of the bladder, on the rming the front part of the sheath of the rectum. The hinder the fascia is similarly attached to the rectum, and sends a pro- n downwards on the lower part of the gut, which becomes ly thinner and is lost a short distance from the anus.

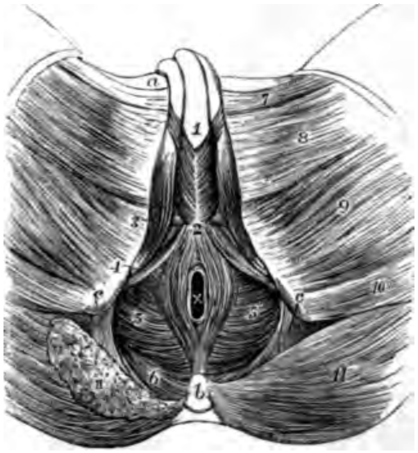
e female the vagina receives an investment from the recto-vesical orresponding to the prostatic sheath of the male. In other the arrangement of the pelvic fascia is substantially the same in sexes.

LES.—The muscles of the perineum differ somewhat in the two nd must therefore be separately described in each. In both ey may be divided into two groups, according as they are more tely connected with the lower orifice of the alimentary canal or e genito-urinary outlet. In both groups superficial and deep are to be distinguished.

N THE MALE.—*a.* ANAL MUSCLES.—The **internal** or **circular er** is a thick ring of unstriped muscle continuous with the cir- res of the rectum, and will be referred to along with the anatomy organ.

**uperficial** or **external sphincter** muscle (sphincter ani ex-

Fig. 222.



—SUPERFICIAL MUSCLES OF ERINEUM IN THE MALE d from Bourgery). (A.T.)

e of the pubis; *b*, coccyx; on the tuberosity of the oints by a line to the great ic ligament; ×, anus; 1, the corpus spongiosum front of the bulbo-caver- les; 2, central point of the ; 3, ischio-cavernosus; 4, s perinei; 5, levator ani; *b*, external sphincter of the rounding ×, is the internal ; 6, coccygeus; 7, adductor 8, gracilis; 9, adductor 10, semitendinosus and 11, on the left side, the aximus entire; 11′, the on the right side, so as to art of the coccygeus muscle.

is a layer of fibres nearly an inch in depth on each side, mmediately beneath the skin surrounding the margin of the anus. ptical in form, and is attached posteriorly by a small tendon to nd back of the coccyx, usually receiving also some fibres from lying integument. Passing forwards it divides into two parts which enclose the anus and meet again anteriorly, where the superficial fibres end in the skin, some of the innermost ones decussating across the middle line, while the larger part becomes blended with the transverse and the bulbo-cavernosus muscles in the central point of the perineum.

The *central point of the perineum* is the mesial part of a small transverse tendinous septum in which several muscles of the perineum meet. It is placed about an inch in front of the anus, and immediately behind the bulb of the urethra in the male, behind the vulval orifice in the female. The tendinous structure is, however, not unfrequently entirely absent, in which case the muscles are directly continuous with one another.

The **levator ani** is a broad fleshy layer which extends from the anterior and lateral parts of the pelvic wall downwards and inwards to the middle line, and forms, together with its fellow of the opposite side, a muscular floor to the greater part of the pelvic cavity. It takes origin from the pelvic surface of the pubis by thin tendinous fibres, placed between and usually intimately adherent to the pubic attachments of the obturator and recto-vesical fasciæ; from the pelvic fascia along the line of origin of the recto-vesical fascia; and to a slight extent from the ischial spine. Some fasciculi are also frequently added to the fore part of the muscle from the upper layer of the deep perineal fascia. The fibres of the hinder and larger portion of the muscle, including all those which are derived from the ischial spine and the pelvic fascia, converge as they descend upon the side of the rectum, and are inserted into the lateral margin of the lower part of the coccyx, and into a narrow mesial aponeurosis, common to the muscles of the two sides, between the coccyx and the anus: a smaller part of the muscle, continued from the pubic origin, passes over the side of the prostate, and is inserted into the lower part of the rectum, where it becomes connected with the fibres of the external sphincter and slightly with those of the internal; and the most anterior fibres, which are directed backwards, nearly parallel to the mesial plane, along the lower part of the prostate, meet between that body and the rectum with the corresponding fibres of the muscle of the opposite side, and blend with those of the external sphincter and constrictor urethræ muscles in the central point of the perineum.

Fig. 223.

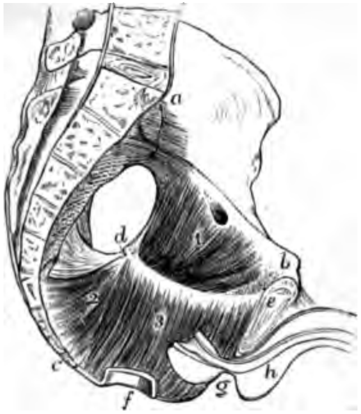


Fig. 223.—LEFT HALF OF THE MALE PELVIS, TO SHOW THE LEVATOR ANI AND COCCYGEUS MUSCLES (after Cloquet). ½

*a*, promontory of the sacrum; *b*, pubic spine; *c*, coccyx; *d*, ischial spine; *e*, symphysis pubis; *f*, a small portion of the anal part of the rectum; *g*, half the prostate gland; *h*, half the bulb and a portion of the penis; 1, part of the obturator internus muscle, exposed by removing the upper portion of the obturator fascia; 2, coccygeus muscle, and above it the sacro-sciatic ligaments; 3, inner surface of the levator ani.

*Relations.*—The upper or pelvic surface of the levator ani is in contact with the recto-vesical fascia, which intervenes between the muscle and the rectum and prostate. The lower or perineal surface, invested by the thin anal fascia, is covered by the fat which occupies the ischio-rectal fossa. The posterior border is adjacent to, and often continuous with, the coccygeus. Between the anterior borders of the right and left muscles the membranous part of the urethra passes downwards as it issues from the prostate.

The **coccygeus** or **levator coccygis** muscle is composed of fleshy and tendinous fibres, forming a thin, flat, and triangular sheet, which **arises** by its apex from the spine of the ischium, and is inserted by its **base** into the border of the coccyx and the lower part of the sacrum.

*Relations.*—The internal or pelvic surface of this muscle assists in supporting the rectum: its external surface is intimately united to the small sacro-sciatic ligament.

The levatores ani and coccygei muscles together have been appropriately named by Meyer the *pelvic diaphragm.*

*Varieties.*—The coccygeus is sometimes inserted wholly into the side of the sacrum. A few fleshy and tendinous fibres are occasionally seen passing from the lower part of the anterior surface of the sacrum to the coccyx, constituting the *sacro-coccygeus anticus* or *curvator coccygis* muscle.

*b.* GENITO-URINARY MUSCLES.—These are three muscles on each side, placed immediately beneath the superficial perineal fascia, viz., the transversus perinei, the ischio-cavernosus, and the bulbo-cavernosus, and one single muscle more deeply placed, between the layers of the triangular ligament, viz., the constrictor urethræ.

The **transversus perinei** muscle arises from the inner side of the ischial tuberosity, immediately above (deeper than) the origin of the ischio-cavernosus, and is directed obliquely forwards and inwards to unite with the muscle of the opposite side, as well as with the external sphincter and bulbo-cavernosus, at the central point of the perineum. Behind this muscle the superficial perineal fascia turns upwards to join the base of the triangular ligament.

*Varieties.*—The transverse muscle is exceedingly variable in its arrangement. It is sometimes absent, and at other times one or more small muscular slips are found lying on the same plane with it, in front or behind. It may also be inserted wholly or in great part into the bulbo-cavernosus or external sphincter. As a rare occurrence a muscular slip has been seen springing from the fascia at the lower border of the gluteus maximus, and inserted into the triangular ligament on its lower surface (Henle), or on its upper surface (G. D. T.).

The **ischio-cavernosus** or **erector penis** muscle, embracing the crus penis, arises from the inner part of the tuberosity and ramus of the ischium behind and on each side of the attachment of the crus. From this origin the fleshy fibres are directed forwards to a tendinous expansion which is spread over the surface of the crus, and is inserted into the outer and under sides of that body towards its fore part.

*Variety.*—Houston has described ("Dublin Hosp. Reports," v., 458), under the name of *compressor venæ dorsalis penis*, a muscular slip separated from the outer part of the erector penis by an interval, though apparently belonging to that muscle. It arises from the pubic ramus, in front of the origin of the erector muscle and the crus of the penis, and, passing upwards and forwards, is inserted by joining its fellow in a median aponeurosis above the dorsal vein. This muscle, which is well developed in the dog and several other animals, is by no means constant in the human subject.

The **bulbo-cavernosus** or **ejaculator urinæ** muscle is united with its fellow of the opposite side in a median tendinous raphé, continued forwards from the central point of the perineum, and the two muscles cover the bulb and the adjacent part of the corpus spongiosum urethræ.

The fleshy fibres arise from the central point of the perineum and from the median raphé, and are directed outwards and forwards on the surface of the corpus spongiosum. The greater number ascend between the crus penis and the corpus spongiosum, and end on the dorsum of the latter body by joining those of the opposite side in a strong aponeurosis. At the fore part a small portion of the muscle passes to the outer side of the corpus cavernosum, where it is attached in front of the ischio-cavernosus, sending also a tendinous expansion over the dorsal vessels of the penis (Kobelt); and the posterior fibres, shorter than the anterior, are inserted by side of the bulb into the under surface of the triangular ligament.

The fibres which invest the most prominent part of the bulb are more or less distinct from those contiguous to them, and have been described by Kobelt as forming a separate muscle, to which he has given the name *compressor hemisphærium bulbi.* The fibres of this muscular slip are connected by a small tendon, above the urethra, with the corresponding part of the opposite side.

The **constrictor** or **compressor urethræ** muscle consists of fibres attached on each side to the ischio-pubic rami, as well as to the adjacent surfaces of the fascial layers between which it is enclosed, and extending for the most part transversely across the subpubic arch, some of them in front of, and others behind, the membranous part of the urethra, for which they form a kind of sphincter. In some bodies a median tendinous raphé divides the muscle more or less completely into lateral halves. The hindmost fibres of this muscle are sometimes described separately under the name of *transversus perinei profundus.*

While the greater number of the muscular fibres contained between the layers of the triangular ligament pass transversely from side to side as above stated, there are usually to be recognized, especially in well-developed subjects, other collections which take different directions. Thus, one set of fibres passes obliquely from behind forwards and inwards; another set surrounds the urethra circularly: and on the inferior surface of the constrictor muscle a longitudinal slip of variable breadth extends from apex to base of the triangular ligament. All these bundles are, however, intimately connected together, and pass gradually into one another, so that they cannot properly be regarded as forming distinct muscles. The longitudinal fasciculi described by James Wilson (Med. Chir. Trans. i., 176), as passing from the pelvic surface of the pubis on each side, and meeting behind the membranous part of the urethra, have not been generally recognized by succeeding anatomists. (On the arrangement of the constrictor urethræ muscle, as well as of the other muscles and fasciæ of the perineum, consult Henle, Eingeweidelehre," and M. Holl, Archiv f. Anatomie, 1881, 225).

*Relations.*—The constrictor urethræ is separated from the levator ani by the upper layer, and from the superficial muscles of the fore part of the perineum by the lower layer of the triangular ligament. Embedded in the substance of the muscle on each side at its origin from the bone are the pudic vessels and the dorsal nerve of the penis, and more mesially are the vessels of the bulb and the gland of Cowper.

Within the constrictor muscle the membranous part of the urethra is surrounded by involuntary muscular fibres which form part of its proper wall, and will therefore be referred to in the description of the reproductive organs in Vol. II.

**Nerves.**—The external sphincter receives offsets from the fourth sacral nerve and the inferior hæmorrhoidal branch of the pudic nerve; the levator ani ourth sacral and the perineal branch of the pudic ; and the coccy-the fourth sacral nerve.

rficial genito-urinary muscles are supplied by the perineal branch of ierve, and the constrictor urethræ by the dorsal nerve of the penis.

.—The *sphincters* of the anus cause by their contraction occlusion of re. The contraction of the external is usually maintained involun-gh it may be rendered firmer by an act of the will ; that of the in-holly involuntary.

*tor ani* and *coccygeus* act principally in supporting and to a slight ex-; the floor of the pelvis. They thus come into play with the muscles minal wall in forcible expiratory and other expulsive efforts. The can also compress the lower part of the rectum, and in this way rectly in the evacuation of the bowel.

*sversi* acting together draw backwards and fix the central point of the thus assisting to give a base of support to the ejaculator muscles.

*o-cavernosus* serves to compress the crus penis and thus assists in pro-t least in maintaining the erection of the penis.

*o-cavernosi* compress the bulb and the adjoining part of the corpus ı, so as to eject forcibly any fluid lodged in the urethra. They come at the end of the process of micturition, when their contraction voluntary act, and in the emission of the semen, when it is involun-

*trictor urethræ* diminishes the calibre of the urethra and expels its it contracts at the end of micturition, so as to assist the bulbo-ı clearing the canal. According to Henle the constrictor takes also nt share in producing the erection of the penis, by compressing the corpora cavernosa, which are contained between its fibres.

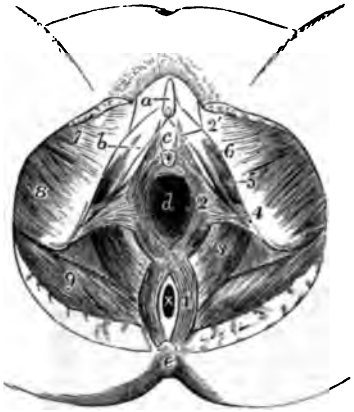
THE FEMALE.—In this sex the anterior fibres of the **levator** ice the vagina as they do the prostate in the male.

**nsversus perinei** and the **external sphincter** are arranged in the same manner as in the male.

**ector clitoridis** (ischio-cavernosus) differs from the erector ie male by its smaller size alone.

**hincter vaginæ** (bulbo-cavernosus) is attached behind to the oint of the perineum, in rith the external sphincter versus perinei muscles ; open out to surround the ifice and vestibule, closely ; on the outer side the two bulbs of the vestibule ; again ng each other in front, they become narrow, and are inserted on the corpora cavernosa of the clitoris, a fasciculus crossing

Fig. 224.



MUSCLES OF THE PERINEUM IN FEMALE. (A. T.) ¼

; *b*, crus clitoridis ; *c*, is placed bule above the orifice of the vagina ; ×, anus ; *e*, coccyx ; sphincter of the anus ; 2, ginæ ; 2′, some of its fibres the clitoris ; 3, levator ani ; t ischial tuberosity, points to sus perinei (the inner portion of is represented too far forwards ) ; 5, 6, ischio-cavernosus ; 7, adductor magnus, semitendino-, gluteus maximus.

over these and including the dorsal vein; some of the inner fibres end in the mucous membrane of the vestibule in front of the urethral orifice. The two halves of this elliptical muscle appear to correspond strictly to the bulbo-cavernosi muscles in the male.

The **constrictor urethræ**, or **transversus perinei profundus**, differs from the corresponding muscle of the male in being, like the deep perineal fascia between the layers of which it is contained, almost completely divided into lateral halves by the vagina. The fibres spring on each side from the margin of the ischio-pubic rami; those of the fore part of the muscle are directed transversely across the subpubic arch in front of the urethra; while those of the hinder and larger part pass inwards, some transversely, others obliquely, and blend with the wall of the vagina. The muscular substance consists in great measure of unstriped fibres (Henle).

## MORPHOLOGY OF THE FASCIÆ AND MUSCLES OF THE TRUNK AND HEAD.

**Fasciæ.**—There is a general correspondence in the relation of the deep fascia to the skeleton and masses of the trunk muscles throughout vertebrate animals. In its simplest and lowest form the general investing fascia is prolonged from the surface towards the skeleton in four places, viz., two median, forming what have been called respectively the *neural* and *hæmal* septa, and two lateral, one on each side, running towards the transverse processes of the vertebræ. The layers of the hæmal septum are in close contact in the caudal region, but they are separated and somewhat complicated in the rest of the trunk by the interposition of the visceral cavity between them.

In man and the higher animals the dorsal part of the general investing fascia is represented by the tendinous attachments of the trapezius, latissimus dorsi, and serrati postici muscles, and by the vertebral aponeurosis and deep temporal fascia, while the deep fascia of the side and front of the trunk, neck, and head, and the aponeurotic sheaths of the limbs correspond with its ventral portion. The neural septum remains as the ligamentum nuchæ and the supraspinous and interspinous ligaments. The hæmal septum partly constitutes the linea alba, and is elsewhere separated into two as an investment of the visceral cavity, forming the transversalis, iliac and pelvic fasciæ. The lateral septum, which is strongly developed in fishes and amphibia, is only seen at all clearly in the middle layer of the lumbar fascia of man and the higher animals, being in them situated much nearer the dorsal than the ventral aspect of the body. This difference of position is coincident with the greater development of the ventro-lateral muscles and the limbs in the higher than in the lower vertebrates.

**Muscles.**—It has already been stated (p. 188) that the muscles of the trunk fall into two primary sets, separated by the embryonic vertebral axis, and known as the epaxial and hypaxial muscles; and that the former are again subdivided into a dorsal and a ventral group, which are partly separated from each other by the above-mentioned lateral septum, and which correspond to the dorso-lateral and ventro-lateral divisions of the great lateral muscle of fishes and tailed amphibia.

The *hypaxial* muscles (subvertebral, Gegenbaur), in man but little developed, are placed on the ventral aspect of the vertebral column, and in some parts spread round the internal surface of the walls of the visceral cavity, and even extend across that cavity, giving rise to the various diaphragms. They include the rectus anticus major and longus colli in the neck; the postcardiac diaphragm or midriff in the dorso-lumbar region; and more postaxially the psoas and pyriformis, extending outwards to the lower limbs, and the pelvic diaphragm or levator ani; while the occasionally present curvator coccygis represents the prolongation of these muscles on the ventral surface of the caudal vertebræ of some of the lower animals. It is proper to state, however, that the morphology of the [illegible]ypaxial is by no means certain, inasmuch as their mode of development has not yet been worked out, and they are regarded by many anatomists (Humphry and Balfour among others) as being merely separated portions of the ventro-lateral muscle.

The *dorso-lateral* muscle consists of fibres which more than any others retain their original segmented character and longitudinal direction. It is represented in man by the mass of muscles which lies in the vertebral groove of the back, and which, arising from the lower vertebræ, splits as it passes upwards to be inserted into other vertebræ, the ribs and the skull. It may be divided into three sets of muscles, characterized by the different directions of their fibres. The *first* set consists of those which run for the most part in a longitudinal direction, as from spine to spine, in spinalis and interspinales; from transverse process to transverse process in longissimus dorsi and intertransversales; or from rib to rib in ilio-costalis. The *second* set consists of muscular fibres directed more or less obliquely upwards and outwards from spines to transverse processes, as in splenius capitis and colli, rectus posticus major and obliquus inferior. The *third* set is also oblique, but its fibres are directed upwards and inwards from transverse processes to spines, as in complexus, semispinalis, multifidus, and obliquus superior; and from transverse processes to laminæ, as in rotatores dorsi.

In the postaxial part of the trunk in tailed animals this dorsal series of muscles is continued backwards without interruption as the superior caudal muscles, and in man a muscular slip is occasionally found developed as an extensor coccygis; but in general, owing to the very slight development of the caudal vertebræ, and the large size of the pelvic girdle, the dorso-lateral muscles do not in man extend beyond the upper part of the sacrum.

Preaxially this muscle is prolonged to the side of the head, where it forms the group of temporal, pterygoids, masseter, and probably the orbital muscles. The connection between these muscles and the dorsal muscles is well seen in the tailed amphibia, where the fibres of the dorsal muscle are directly continuous with those of the temporal. In man this continuity is interrupted in consequence of the great expansion of the cranium, a considerable portion of which is exposed between the temporal and the neck muscles.

The *ventro-lateral* muscle, while equally simple in the lowest vertebrates with the dorso-lateral, shows in the higher animals a much greater degree of complexity, both of form and attachments. It springs from the ventral surfaces and tips of the transverse processes of the vertebræ, as well as from the lateral septa and general fascial investment; and by means of its connection with the last-mentioned structure the superficial portion of the muscle is prolonged dorsally, and gains an attachment to the spinous processes, so that it covers the dorso-lateral muscle almost completely. Ventrally, it extends round the visceral cavity to the median line, where it is separated from the corresponding mass of the opposite side by the hæmal septum, and it thus forms the whole thickness of the muscular portion of the body-wall. It comes into connection with the orifices only of the alimentary canal, where portions of the right and left muscles become united and form the external sphincters. It is farther characterized by the disposition which certain of its sclerotomes show to become the seat of ossification in the hyoid bone, ribs and limb-girdles.

According to the direction of its fibres the trunk portion of this muscular mass may be divided into two groups of muscles, a *mesial* with longitudinally directed fibres and a *lateral* with more or less obliquely directed fibres.

The *mesial* group is represented in man by the rectus abdominis, supracostalis (an occasional muscle), the sterno-mastoid, sterno-hyoid, sterno-thyro-hyoid and the anterior belly of the omo-hyoid, the anterior belly of the digastric, genio-hyoid and genio-glossus; and it repeats more closely the simple segmented condition of the dorsal muscle than is the case with the lateral fibres. In fishes the oblique fibres are almost entirely wanting, and in the lower vertebrates generally they are less developed than the longitudinal. On the other hand, in the higher forms, as in man, the oblique fibres are the more important, the longitudinal fibres being in certain places (thorax) absent altogether, or only occasionally present as supracostalis. In some animals, as Lepidosiren, the oblique fibres of the abdomen are directly continuous with the longitudinal, but in man greater differentiation exists, for the lateral muscles are merely prolonged forwar[illegible] aponeuroses which form a fibrous sheath for the rectus on each side of the middle line. man these longitudinal fibres have little or no connection with the muscles of limbs, but in urodelans they are continued outwards upon the ventral aspec each limb as part of the pectoralis major and gracilis.

Longitudinal fibres are also found in the pyramidalis, a small rudiment muscle in man, but which in marsupials and monotremes is extremely la and as a rare variety between the lateral oblique muscles forming a *lat rectus*, which consists of a few fibres running between the lower ribs and ilium. Posteriorly again the longitudinal direction is maintained by cer fibres of the quadratus lumborum.

The *lateral* group of trunk muscles, distinguished by the oblique directio their fibres, is divisable usually into three or it may be into four layers. In lowest vertebrates this stratification does not occur, but in the higher ani it is coincident with the differentiation of separate muscles. Of these l three are very constant in their relations and extent, but the fourth, which i most superficial, though very constantly found, is on the whole only a pa layer. In man these layers are represented, the first three by the abdom muscles, the external and internal oblique and transversalis respectively, and fourth by the platysma myoides, the facial, auricular and epicranial muscles.

The transverse or deepest of these layers is represented by the transver muscle, which is prolonged into the thorax by the triangularis sterni; and subcostals, small in man, but very largely developed in birds, serpents, &c., a retrahentes costarum and levatores costarum interni, must also be referr this layer.

The internal oblique is directly continuous with the lower internal interco and the external intercostals and levatores costarum are probably also diff tiated portions of the same layer. In series with these are the scaleni anterior intertransverse muscles in the neck, and the quadratus lumborum lateral intertransverse muscles in the loins. Inferiorly, the middle furnishes the coccygeus (ischio-caudal), the constrictor urethræ, ischio-bulbo-cavernosus, and transversus perinei. Laterally, it gives the costo-sca muscles (serratus magnus with the levator scapulæ) and the costo-cor (subclavius) to the shoulder-girdle; and the posterior belly of the omo- forms a connection between this layer of the lateral oblique fibres and the longitudinal fibres. Superiorly, the hyo-glossus, the constrictors of the pha the styloid muscles with the posterior belly of the digastric, and the f and palatal muscles are probably also derived from this layer (Humphry).

The external oblique layer is prolonged upwards upon the side of the ches outwards upon the upper limb as pectorales and latissimus dorsi, and bet the limb and head as cleido-mastoid and trapezius. The rhomboids and s postici appear to be segmented deeper portions of this layer, and its most axial derivative is the mylo-hyoid.

The fourth layer, corresponding to the panniculus carnosus of animals, to be mainly developed from the cutaneous surface of the last or external o layer; or it may be an independent layer developed in close connection wit skin (exoskeleton) and fascial investment. In man this layer extends only the surface of the head and neck, and very slightly over the shoulder. It the subcutaneus colli or platysma myoides, and those slight continuations wards which are found upon the surface of the pectoral and deltoid muscl well as the occasional sternalis muscle. On the surface of the head this the epicranial muscles, with the intervening aponeurosis, the auricular an facial muscles. All these muscles are attached to bone usually by one end the other being attached to the skin or to the cartilage of some mov structure, but in some cases they may reach the deeper structures by both Portions of this layer in animals may blend with or even take the place of of the subjacent muscles, or they may be enormously developed as compared other layers, or lastly, the whole layer may be aborted. (See, in addition t works quoted at p. 188, Gegenbaur, "Elements of Comparative Anatomy," Transl. 1878, and Balfour, "Comparative Embryology," vol. ii., 1881.)

# ANGEIOLOGY.

THE vascular system, as a whole, comprehends two sets of vessels, viz., those carrying blood and those carrying lymph or chyle. The first, constituting the sanguiferous system, includes the heart or central propelling organ and the peripheral channels for the blood, viz., the arteries, capillaries and veins. The absorbent system includes the lymphatic and lacteal vessels, together with the lymphatic and mesenteric glands with which many of these vessels are connected. The descriptive anatomy of the heart is given with that of the thoracic viscera in the second volume: the account of the minute structure of the blood-vessels and of the lymphatic vessels and glands will be found in the part of the same volume which treats of General Anatomy. Under the present division, therefore, will be brought only the descriptive anatomy of the principal blood-vessels and absorbent vessels.

## 1.—BLOOD-VESSELS. ARTERIES AND VEINS.

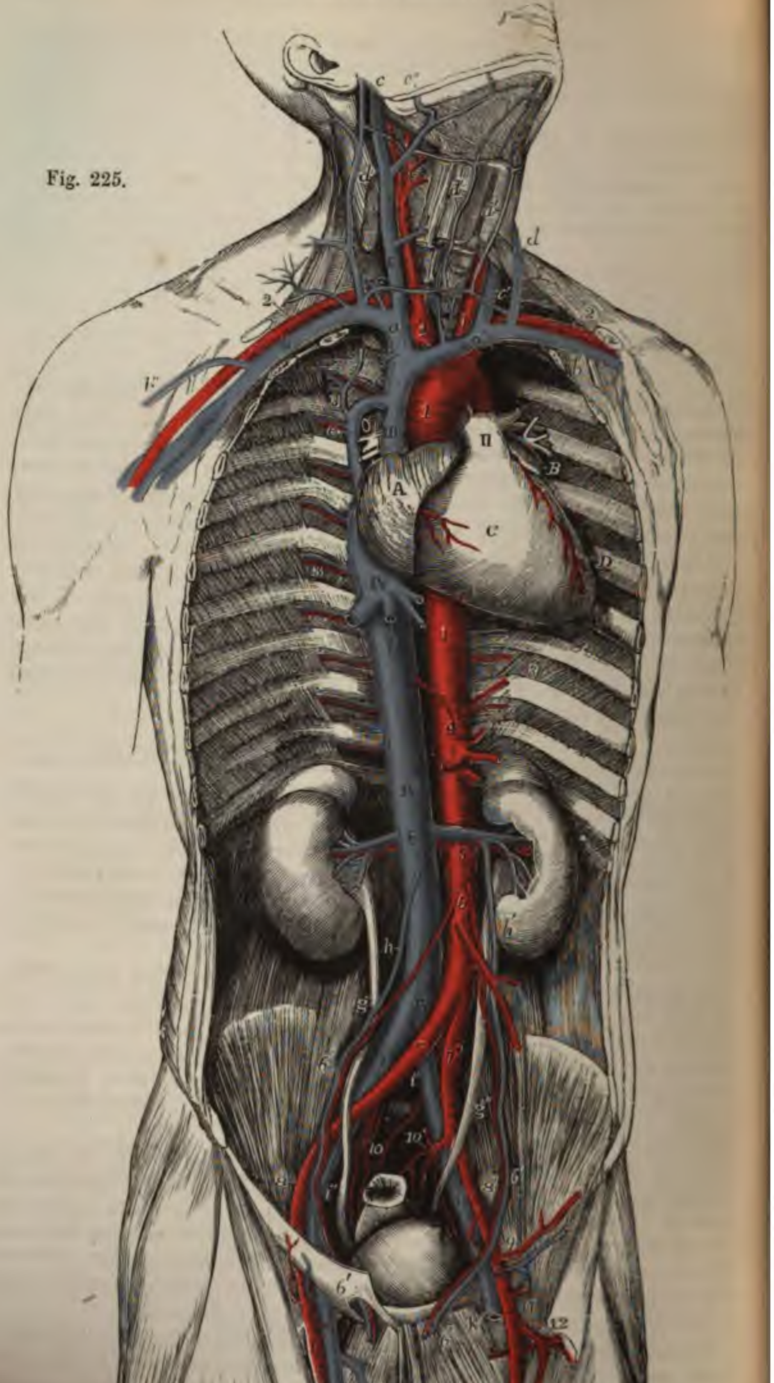
The descriptive anatomy of the blood-vessels includes an account of their origin, extent, form, position, mode of division, distribution, anastomosis with each other, and relations to other parts. Seeing, however, that the blood-vessels are subject to frequent variations, while the most constant forms and modes of distribution are described as the normal, it will be necessary also to make frequent reference to the more important varieties which have been observed among them.

The varieties of blood-vessels may consist of a deviation either from the usual size of the channels or from their usual position and their connection with other vessels. In the latter case they may be described as consisting in differences of origin from the main stem, or from a branch, or from quite another source than that which is the most common or usual. But some varieties are so common that it becomes doubtful which form is to be described as normal.

Many of these varieties are not only compatible with life, but cause no disturbance whatever in the performance of the ordinary functions of the body. Others are of such a nature as to be compatible only with the conditions of the circulation subsisting during intrauterine life, and therefore prove fatal at birth. Some are of considerable interest from their frequency, and others from their existing in situations which are liable to diseases requiring surgical operations for their cure.

Many vascular varieties repeat forms which are natural in different species among the lower animals; others are obviously due to the persistence of early fœtal forms of distribution; and not a few are expli-

Fig. 225.



.—General view of the heart and blood-vessels of the trunk, from
before in a male adult. (A. T.) $\frac{1}{4}$

ht auricle ; B, left auricular appendix ; C, right ventricle ; D, part of the left
; I, I, aortic arch, and descending thoracic aorta ; II, trunk of the pulmonary
iding into its right and left branches, and connected to the aorta by the cord
ictus arteriosus ; III, superior vena cava ; IV, IV, inferior vena cava.
minate artery and right carotid ; 1′, left carotid ; 2, 2, right and left subclavian
3, intercostal vessels ; 4, inferior diaphragmatic arteries ; below 4, the cœliac
superior mesenteric artery ; 5, renal arteries ; 6, 6′, the spermatic arteries ;
the inferior mesenteric ; 7, 7′, right and left common iliac arteries ; 8, 8′, ex-
ic arteries ; 9, left epigastric and circumflex iliac arteries ; 10, 10′, internal iliac
and between these two figures, the middle sacral artery ; 11, 11, femoral arteries ;
femoral artery of the left side.
t innominate vein ; *a*′, the left ; *b*, *b*′, right and left subclavian veins ; *b*″, the
vein of the right arm ; *c*, *c*′, internal jugular veins ; *c*″, right facial vein ; *d*, *d*,
jugular veins formed by the posterior auricular and part of the temporo-maxillary ;
or jugular veins with the transverse branch joining them ; *e*, azygos vein passing
root of the right lung ; *f*, hepatic veins ; *g*, renal veins ; to the sides are seen the
nd the suprarenal bodies ; *g*′, right, *g*″, left ureter ; *h*, *h*′, spermatic veins ; *i*, *i*,
iliac veins ; *i*′, *i*′, external iliac veins ; *k*, *k*, femoral veins ; *l*, internal saphenous
e right side.

n the supposition of abnormal enlargement or diminution of
ly existing vessels.
fuller information on the natural and abnormal distribution of
od-vessels, the reader may consult the works of Haller and
ann, and more especially the "Anatomy of the Arteries," by
l Quain, 1844 ; Henle's "Handbuch," vol. iii., part 1, 2nd Ed.,
n which a connected view of the varieties by W. Krause is given ;
er special treatises.
dimensions of the arteries and the thickness of their coats have
udied by C. Krause ("Handbuch," 3rd Ed. by W. Krause, vol ii.,
Kölliker (Mikroskop. Anat. ii., 512), Gimbert (Journ. de l'anat.,
536), Beneke (Schriften der Marburger Gesellsch. z. Beförd. d.
aturwiss. xi., 1880), and Valerie Schiele-Wiegandt (Virchow's
, 1880, lxxxii., 27) ; and the observations of the two last-named
agree in indicating that, in addition to individual and sexual
ces, both the calibre of the large arteries and the thickness of
valls increase gradually with advancing years. The primary
es of the aortic trunk, and their secondary and tertiary ramifica-
re divided by Henle, according to their average calibre (after
n), into six groups or orders, as shown in the annexed table ;
s classification will be adopted in the following descriptions, the
o which each principal artery belongs being indicated by Roman
within a parenthesis after its name. The average diameter
pulmonary artery and of the several parts of the aorta will be
stated in millimeters, as will also that of the innominate, sub-
, common iliac and external iliac trunks, which are considerably
han the arteries of the first order, but differ too widely in size
ne another to be included in one group.

| ORDER. | AVERAGE CALIBRE. | EXAMPLE. |
|---|---|---|
| I. | 8 mm. ($\frac{1}{3}$ inch) | Common carotid. |
| II. | 6 mm. ($\frac{1}{4}$ inch) | Brachial. |
| III. | 5 mm. ($\frac{1}{5}$ inch) | Ulnar. |
| IV. | 3·5 mm. ($\frac{1}{7}$ inch) | Lingual. |
| V. | 2 mm. ($\frac{1}{12}$ inch) | Posterior auricular. |
| VI. | 1 to ·5 mm. ($\frac{1}{25}$ to $\frac{1}{50}$ inch) | Supraorbital. |

The sanguiferous system consists of two great divisions, comprehend in the lesser or pulmonic and the greater or systemic circulations. the former belong the pulmonary artery and veins, which will be f described.

## PULMONARY ARTERY AND VEINS.

### PULMONARY ARTERY.

The main pulmonary artery is a short wide vessel (diameter 30 m Henle), which carries the dark blood from the right side of the hear the lungs. It arises from the infundibulum of the right ventricle, passes for the space of nearly two inches upwards, and at the same t backwards, to reach the concavity of the aortic arch, where it div into two branches—the right and left pulmonary arteries. The mod attachment of the main pulmonary artery to the base of the ventricl noticed in the description of the heart. At each side of its comme ment is the corresponding coronary artery springing from the aorta, close to its sides are the two auricular appendages. It is at first in f of the aorta and conceals the origin of that vessel; but higher up, w it lies in front of the left auricle, it passes to the left side of the asc ing aorta, and is finally placed below the transverse part of the arch. pulmonary artery and the aorta are united together by connective t and by the serous layer of the pericardium, which for the space of a an inch and a half forms a single tube surrounding both vessels. Ri to the left of its point of bifurcation it is connected to the under of the aortic arch by means of a short fibrous cord, which passes oblic upwards, backwards, and to the left. This is the remains of the *d* *arteriosus*, a large vessel peculiar to the fœtus.

The **right pulmonary artery** (21 mm.), longer and somewhat l than the left, runs almost transversely to the right behind the ascen aorta and the superior vena cava into the root of the right lung, w it divides into two primary branches, the upper of which is distrib to the upper lobe of the lung, the lower to the middle and lower lob

The **left pulmonary artery** (19 mm.), shorter than the right, p horizontally in front of the descending aorta and left bronchus int root of the left lung, also dividing into two branches for the uppe lower lobes of the left lung.

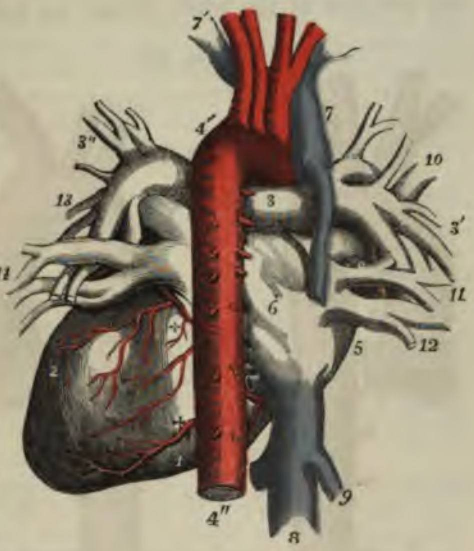
In the root of the lung, the right and left pulmonary arteries lie in front of the bronchus and behind the veins. On the right the bronchus is highest and the veins lowest, while on the left side bronchus sinks to a level between the artery and veins.

The varieties of the pulmonary artery will be referred to along with th the aorta.

### PULMONARY VEINS.

The pulmonary veins are four short trunks which convey red blood from the lungs to the left side of the heart, and whic found, two on each side, in the root of the corresponding lung. two veins of the *right* side pass below the right pulmonary artery, behind the superior vena cava and the right auricle, to enter the auricle; the upper vein receives one or more branches from the mi be of the right lung. The two *left* pulmonary veins pass in front of e descending aorta to reach the auricle. The distribution of the pulmonary capillaries is exclusively to the membrane lining the air-cells of the lungs.

Fig. 226.



g. 226.—THE HEART AND GREAT VESSELS, FROM BEHIND. (R. Quain.) $\frac{1}{3}$

1, Right, 2, left ventricle; 3, ht pulmonary artery near the vision of the main trunk; 3′, anches of the right pulmonary tery in the root of the right lung; ′, the same of the left; 4′, arch of e aorta; 4″, descending thoracic rta; 5, right auricle; 6, is laced on the division between he right and left auricles; 7, uperior vena cava, being joined by the large azygos vein; 7′, left innominate vein; 8, inferior vena cava; 9, one of the hepatic veins; 10, upper, 11, middle (additional), and 12, lower right pulmonary vein; 13, upper, and 14, lower left pulmonary vein; +, +, branches of coronary arteries.

*Varieties.*—The two veins of one side, more often the left, may unite into a common trunk before entering the auricle. There is frequently a third smaller vein on the right side, coming from the middle lobe of the lung. Other supernumerary veins are of rare occurrence. The upper pulmonary vein of the right side has been seen opening into the superior vena cava (Meckel, Gegenbaur, Bardeleben); that of the left side into the left innominate vein (Bachhammer).

## SYSTEMIC ARTERIES.

### THE AORTA.

The aorta, the main trunk of the systemic arteries, is at its commencement generally a little smaller than the pulmonary artery, but in old persons it becomes rather larger than that vessel (Schiele-Wiegandt, *loc. cit.*). Springing from the left ventricle of the heart, it arches over the root of the left lung, descends along the vertebral column, and, after passing through the diaphragm into the abdominal cavity, ends opposite the fourth lumbar vertebra, by dividing into the right and left common iliac arteries. In this course the aorta forms a continuous single trunk, which gradually diminishes in size from its commencement to its termination (from 28 to 17 mm.), and gives off larger or smaller branches at various points. Different parts of the vessel have received particular names, derived from their position or direction. The short curved part, which reaches from the ventricle of the heart to the lower border of the fifth dorsal vertebra, is named the *arch;* the straight part, which extends from that vertebra to the diaphragm, is the *descending thoracic aorta;* and the remainder of the vessel, down to its bifurcation, is the *abdominal aorta.*

## ARCH OF THE AORTA.

The arch of the aorta commences at the upper part of the l
left ventricle of the heart, behind the pulmonary artery.

Fig. 227.

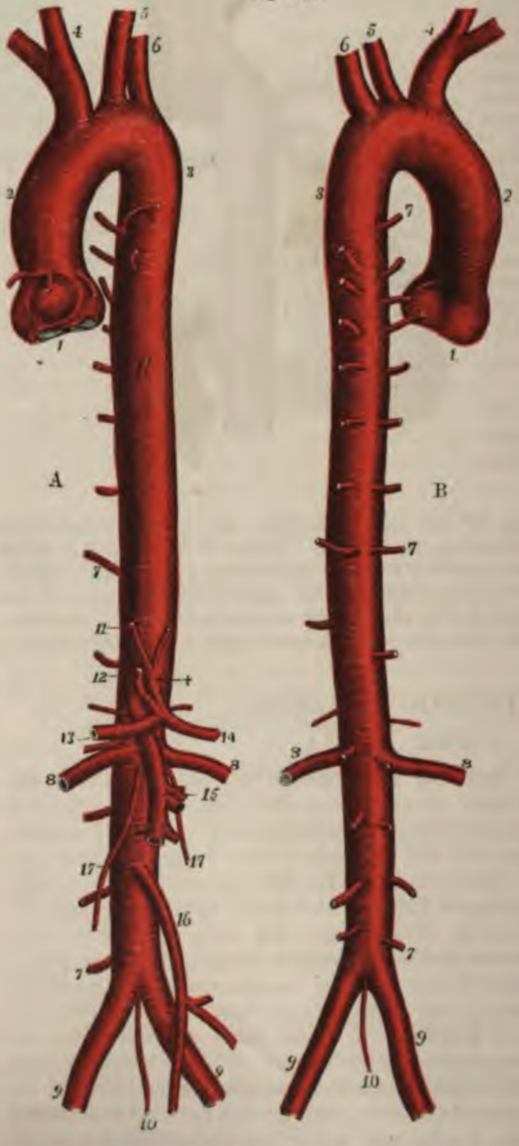


Fig. 227.–
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(R. Quai

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to [illegible] bone. Having gained the level of the upper bo
[illegible] al cartilage of the right side, the vessel alters

and is directed upwards, backwards, and to the left, then directly backwards, orming a well-marked curve round the trachea, to the left side of the ody of the fourth dorsal vertebra. Arrived at that point, it bends downwards, and at the lower border of the body of the fifth dorsal vertebra, on its left side, the arch terminates in the descending thoracic aorta. Near the base of the heart the aorta is enlarged, and presents externally three small bulgings of nearly equal size, corresponding with the dilatations which form the *sinuses of Valsalva* or *sinuses of the aortic valves*, described with the heart. These sinuses are placed, one in front and two behind, and from the anterior and left posterior are given off the two coronary arteries of the heart.

From the difference in the direction and connections of its several portions the arch is described as consisting of an *ascending*, a *transverse*, and a *descending* portion.

The *ascending* portion of the arch of the aorta (28 mm., Henle) is placed at its commencement behind the sternum, on a level with the lower border of the third costal cartilage of the left side; and it rises as high as the upper border of the second costal cartilage of the right side. Its length is about two inches or two inches and a quarter; and its direction is curved. In most cases there exists along the right side a dilatation, named the *great sinus of the aorta.* This dilatation varies in size in different bodies, and occasionally is not to be detected.

This portion of the aortic arch is for the greater part of its length enclosed in the same sheath of pericardium with the pulmonary artery in such a manner that both vessels are covered by the serous membrane, except where they are in contact with each other.

At its commencement the ascending part of the arch is in contact anteriorly with the pulmonary artery, and with the right auricular appendage; but farther up, as the aorta passes forwards and to the right side and the pulmonary artery backwards on the left, the aorta comes into view. It then approaches very near to the sternum, from which it is separated by the pericardium, by the right pleura, and to a variable extent by the thin anterior margin of the right lung; the descending vena cava lies on the right side, and the pulmonary artery passes backwards on the left; while behind are placed the left auricle of the heart and the right pulmonary artery.

The second or *transverse* part of the arch is covered, slightly on the right side, to a much greater extent on the left, by the pleura and lung, and is placed immediately in front and to the left of the trachea, the œsophagus, and the thoracic duct. The upper border of the transverse part of the arch has in contact with it the left innominate vein; and from it are given off the large arteries (innominate, left carotid, and left subclavian), which are furnished to the head and the upper limbs. The lower or concave border overhangs the bifurcation of the pulmonary artery, and is connected with the left branch of that artery by the remains of the ductus arteriosus. This part of the arch is crossed in front by the left pneumo-gastric, phrenic and superficial cardiac nerves, as well as by the left superior intercostal vein; and the recurrent laryngeal branch of the pneumo-gastric turns upwards beneath and behind it.

The *descending* portion of the arch (23 mm.) rests against the left side of the body of the fifth dorsal vertebra, and is covered by the left pleura and lung. To the right side of this part of the arch is the œsophagus with the thoracic duct.

Fig. 228.

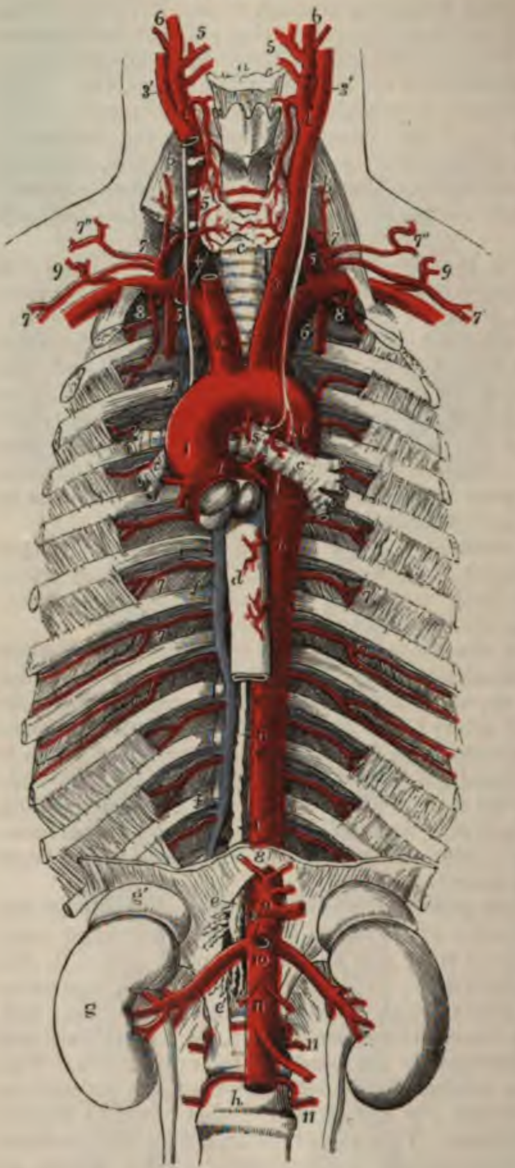


Fig. 228.—View of the thoracic and greater part of the abdominal aorta, showing their principal relations. (A. T.). $\frac{1}{4}$

*a*, the hyoid bone; *b*, *b*, placed on the anterior scalene muscles, point to the upper part of the pneumo-gastric nerves; *c*, the trachea below the isthmus of the thyroid body, and lower down the same letter is on the left bronchus; *c'*, one of the divisions of the right bronchus emerging from behind the aorta; in the hollow of the aortic arch, above 5, are seen the cord of the ductus arteriosus cut short, and the left recurrent nerve passing below the arch; +, is placed on the right side between the recurrent nerve and the vertebral artery as they pass upwards; *d*, the œsophagus; *e*, *e'*, upon the right crus of the diaphragm, mark the receptaculum chyli of the thoracic duct, and its commencement by the lumbar plexus of lymphatic vessels and efferent mesenteric lacteal vessels; *f*, *f*, *f*, on the third, seventh, and eleventh ribs, point to the vena azygos and intercostal veins of the right side; *g*, kidney; *g'*, suprarenal body; *h*, body of the fourth lumbar vertebra.

*I*, ascending part of the arch of the aorta: below this the semilunar valves are seen closed and distended by injection; *I'*, descending part of the arch; *I''*, descending thoracic aorta; *II*, abdominal aorta.

*Branches of the arch and descending thoracic aorta:* 1, right and left coronary arteries; 2, innominate; 3, left common carotid; 4, left subclavian; 5, bronchial arteries; 6, 6, œsophageal arteries; the lower figure points by a line to the thoracic duct; 7, intercostal arteries, marked in the sixth and seventh intercostal spaces.

*Branches of the abdominal aorta:* 8, inferior diaphragmatic arteries cut short; 9, cœliac axis with the gastric, splenic, and hepatic arteries cut short; 10, placed on the aorta below the superior mesenteric artery (cut short) and the origin of the renal arteries; a little below this the origin of the spermatic arteries; below *II*, the inferior mesenteric artery. 11, 11, two of the lumbar arteries.

**BRANCHES.**—The branches given off from the arch of the aorta are five in number. Two of these, named the coronary arteries of the heart, comparatively small, arise from two of the sinuses of Valsalva, and are distributed to the walls of the heart. The other three are large primitive trunks, which supply the head and neck, the upper limbs, and, in part, the thorax, and usually arise from the transverse part of the arch, in the following order :—first, the innominate or brachio-cephalic artery ; second, the left common carotid ; and third, the left subclavian artery. The origin of the left carotid artery is usually nearer to the innominate artery than it is to the subclavian artery of its own side.

**Varieties.**—It will be proper in this place to refer to the varieties which affect the whole aorta, as well as to those of the pulmonary arteries. The former may be distinguished, according as they occur in the whole length of the vessel, or belong to one or other of its parts, those which are very frequent in the arch being especially deserving of notice. These last are of peculiar interest, but as the full explanation of their mode of formation is connected with the history of fœtal development, the reader is referred to the chapter on that subject for further elucidation of the outline of the nature of the varieties which is introduced in this place.

1. The aorta may vary in its *position* and *extent*. Thus, the height to which the arch rises in the upper part of the chest is found to be subject to variation to the extent of one or two vertebræ : so that while in some instances the summit of the arch has been on a level with the top of the sternum, in other cases it it has been as low as the fifth dorsal vertebra.

The distance to which the aorta extends downwards depends on the seat of its division into the common iliac trunks, which frequently varies to the extent of a lumbar vertebra, so that the place of division may be as low down as the fifth or as high up as the third. In rare cases the division occurs still higher.

The position of the aorta with reference to the middle line or vertebral column is also subject to some variation, but such deviation to the side is more frequently the result of pathological changes than of congenital malformation.

A very remarkable malformation of the aorta consists in the greater or less division of the vessel through a part or the whole of its channel into two closely united tubes, by a median septum running through the cylindrical tube from before backwards, or slanting from side to side, as in the cases observed by Cruveilhier, Vrolik, Schröder Van der Kolk, and Allen Thomson, which, when not due to pathological changes, may admit of explanation on the supposition of the fusion of the original double embryonic aorta having remained incomplete.

2. The *Varieties of the Stems*, or main trunks of the aorta and pulmonary artery, are intimately connected and usually associated with malformations of the heart, and frequently with the persistence of the ductus arteriosus. These first parts of the two great arteries, specially enclosed by the pericardium, are derived from the arterial bulb of the fœtal heart, and are liable to variations which may be traced to deviations from the natural mode of their septal division, and of their union with the left or right ventricles of the heart respectively. Thus, these two arterial trunks may be transposed, or each one may be connected with the ventricle to which it does not naturally belong, *i.e.*, the pulmonary artery with the left, and the aorta with the right ventricle. Or the arterial trunks may communicate together more or less freely by deficiency of the septum between them. Or one of the vessels may be nearly or entirely obliterated ; while the other, from unnatural openings left between them, serves as the channel for the stream of blood belonging to both vessels. Or the aorta and pulmonary arteries may be entirely united in one simple stem in connection with a simple heart similar to that of fishes.

3. The *Varieties in the Aortic Arch* itself, along with which must be included those of the ductus arteriosus, are intimately connected with the mode of development of the fourth and fifth fœtal branchial arteries. The natural aortic arch of man, and of all mammalia, is a left one produced by the persistence and develop-

ment of the left fourth branchial arch : in birds it is the right fourth arch which forms the permanent aorta ; and in reptiles both the right and left fourth arches remain patent.

Here it may be proper to call attention to the *complete lateral transposition*, *i.e.*, from right to left and *vice versâ*, which affects the aortic arch and pulmonary vessels, as well as the other parts of the heart, when transposed with or without the transposition of other viscera. Several cases of this kind have been recorded by various observers, and they are usually unattended with any disturbance of the functions or other unnatural condition of structure. There is, in fact, only a change of position, which may be best described by comparing it to that in which the natural parts would appear if viewed by reflection from a mirror. Although this transposition gives rise to no perceptible lesion of function, yet from the direction of the apex of the heart towards the right, and other differences from the natural position, its existence is capable of being ascertained during life

Fig. 229.

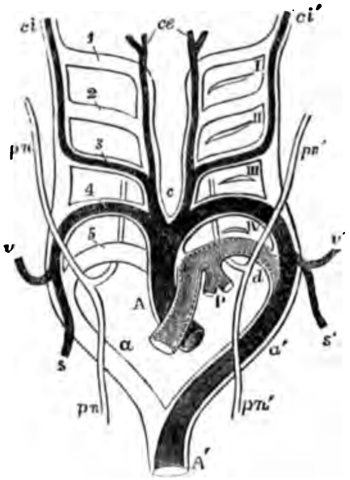


Fig. 229.—DIAGRAM OF THE FŒTAL AORTIC ARCHES, SHOWING THEIR TRANSFORMATION INTO THE PERMANENT VESSELS OF THE MAMMAL (after Rathke). (A. T.)

A, to the right of the primitive arterial bulb, now divided into aortic and pulmonary stems, the latter in front ; *a*, the right, *a'*, the left aortic root ; A', the descending aorta ; on the right side, the double outlines, 1, 2, 3, 4, 5, indicate the five primitive branchial vascular arches ; on the left side, I, II, III, IV, mark the seat of the four branchial or pharyngeal clefts ; *c*, is between the common carotid arteries ; *ce*, the external carotids ; *ci*, the right, *ci'*, the left internal carotid ; *s*, the right, *s'*, the left subclavian ; *v*, the right, *v'*, the left vertebral ; the right fourth arch forms the innominate trunk, and passes on to *v* and *s*, the right vertebral and subclavian arteries ; the left fourth arch passes to *a'*, as the permanent aortic arch ; P, pulmonary arteries springing from the fifth left arch, which at *d* is continued into the left aortic root as ductus arteriosus ; *pn*, right, and *pn'*, left pneumo-gastric nerve, which have been added to Rathke's figure. The permanent systemic arteries are represented in deep shade.

The aortic arch has been observed *completely double* in some rare cases, which admit of being explained on the supposition that both the right and left fourth branchial arches have remained pervious and undergone development. The ascending aorta, having the usual relation to the pulmonary artery, divides above into two branches which pass backwards, embracing the trachea and œsophagus, and join on the left side of the spine to form the descending aorta. Each arch gives origin to the common carotid and subclavian arteries of its own side, in the order mentioned. Examples of this condition have been recorded by Hommel, Curnow, and some others. In one remarkable instance, however, known as Malacarne's case, the arrangement was different, and seems to have been the result of some unexplained mode of development of the arterial stem. The ascending aorta divided close to the heart, and the two arches embraced the trunk of the pulmonary artery, as well as the trachea and œsophagus ; and each gave rise successively to a subclavian, an external, and an internal carotid artery, an arrangement which is inconsistent with the known modes of development of the branchial vascular arches.

The existence of a *right aortic arch*, that is, one passing to the right of the trachea and gullet, instead of the usual left arch, is easily explained on the supition of the right fourth branchial arch having been developed instead of the ; and accordingly there are instances of this variety, in which no other viation from the natural condition of the parts exists beyond what proceeds the change of side taken by the aortic arch, leading to the innominate or chio-cephalic artery being a left one, or furnishing the left subclavian and otid arteries, and the succeeding vessels being the right carotid and right subvian. The recurrent laryngeal nerve forms its sling on the right side round aortic arch, and on the left round the arch of the subclavian artery.

4. Varieties of the *posterior part of the arch* and *ductus arteriosus* belong prodly to the changes occurring in connection with the posterior embryonic aortic ots.

One of the most frequent varieties of this group is that of the subclavian artery (of the right side, when the aortic arch is left or normal) rising, as it has been described, from the back part of the arch, or fourth in the series of vessels proceeding from it, but which, according to embryological elucidation, would be more correctly designated as the subclavian artery formed in connection with one of the posterior aortic roots; the natural anterior root and arch being abnormally closed. In such cases the subclavian artery takes its course behind the trachea and gullet to reach its subsequent natural place as it passes between the scalene muscles and over the first rib.

Fig. 230.

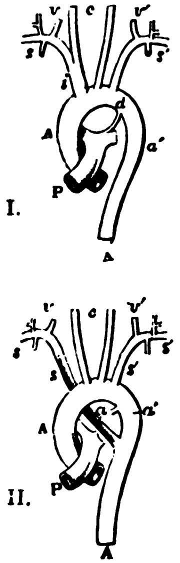


Fig. 230.—Diagram of the natural origin of vessels from the aortic arch as compared with the displaced subclavian artery. (A. T.)

I., The normal disposition; II., the right subclavian artery displaced or proceeding from the right aortic root. A, A, ascending and descending parts of the thoracic aorta; P, pulmonary stem; *d*, ductus arteriosus; *a*, right aortic root or its remains; *a′*, left aortic root; *c*, common carotid arteries; *i*, innominate artery; *s*, right, and *s′*, left subclavian artery; *v*, right, and *v′*, left vertebral artery.

A similar variety may occur in an instance of right aortic arch, in which case it is the left subclavian artery which takes the abnormal course. In both examples of this variety, the anterior part of the subclavian arch being absent, the inferior laryngeal nerve is not recurrent, but passes directly to the larynx without being drawn down as a sling or loop by the subclavian artery.

There are also many instances of transitions or gradations between these cases and the completely double aortic arch. See a paper on "Varieties of the Arch of the Aorta," by Turner, in Brit. and For. Med. Chir. Review, 1862, and "Description of a Case of Right Aortic Arch," by Allen Thomson, in Glasg. Med. Journ. 1863, in which such cases are more fully explained, and also the works of Henle, Hyrtl, and Struthers.

In some of the instances of aberrant subclavian artery of the kind now referred to, the vertebral artery is detached from the subclavian, and rises directly from the arch of the aorta.

Under the same division may be brought those numerous varieties in the closure of the ductus arteriosus, and its union with the aorta or other vessels which have been observed; the greater number of which it will be understood, from the nature of the change in the circulation which takes place at birth, are only compatible with intrauterine life. Such are those cases in which the pulmonary artery leads through the ductus arteriosus, or fifth branchial arch of the left side, into the descending aorta; while the aortic arch itself is more or less separated by a constriction or even a complete closure of its tube from the descending part of the aorta. It is remarkable, however, that in some rare cases of the kind now referred to, life has been prolonged after birth, and the ductus arteriosus having become closed, probably gradually, the descending aorta has come to receive a full supply of blood from enlarged anastomosing vessels (internal mammary, intercostal, &c.) passing between the vessels which rise from the arch and those connected with the descending aorta.

Along with the same division may also be classed the series of converse cases, in which the pulmonary arch being closed anteriorly, the pulmonary vessels have received their supply of blood from the descending aorta. Such examples of the origin of the pulmonary arteries from the aorta, as they have been styled, and examples of the origin of the left, or in very rare cases of the right subclavian artery from the ductus arteriosus or from one of the pulmonary arteries, are explicable by reference to the same group of developmental phenomena.

5. The varieties in the *number* and *position* of the *vessels springing from the arch* of the aorta are extremely numerous: some very frequent, others comparatively rare. These vessels may be all collected into one trunk, or they may rise separately from the aorta to the number of six. In the rare case of one trunk, we may suppose the anterior aortic roots to be combined so as to collect all the branches proceeding from them together, as naturally occurs in the horse, forming what is called the anterior aorta.

The cases of two vessels from the arch may be of two kinds; one, which is the commonest of all the varieties of the aortic vessels, in which the left carotid is united with the innominate artery into a common stem; and the other, comparatively rare, in which there are two innominate trunks, as in birds.

Three is the normal number of branches rising separately from the arch in man, and apes, and some other mammals. There is, however, a rarer form of variety in which the number is the same, and in which, as occurs naturally in some cetacea, the subclavians are both separate vessels, and the two carotids spring from a common stem in the interval between them.

The commonest form of the condition in which there are four vessels taking origin from the aortic arch is that in which the sessile left vertebral artery rises between the left carotid and subclavian arteries. The origin of four large arteries in the order, right carotid, left carotid, left subclavian, and right subclavian, has been referred to (p. 357). A rarer form is that in which the vessels rising from the arch are successively the right subclavian, the right carotid, the left carotid, and the left subclavian arteries.

The number of five arteries proceeds from the division of the innominate into subclavian and carotid, together with separate origin of the left vertebral artery.

In the case of six vessels proceeding from the single arch, of which there are a few instances described, the vessels were in the following order, which is that which might be anticipated from the mode of development, viz., right subclavian, vertebral and carotid, left carotid, vertebral and subclavian arteries.

There are, however, many other varieties and modifications of those already mentioned, for which the fuller works already quoted may be referred to.

## BRANCHES OF THE ARCH OF THE AORTA.

The **coronary arteries (iv)** are two small vessels, right and left, which arise from the root of the aorta in the upper parts of two of the sinuses of Valsalva, on a level with the margins of the semilunar valves.

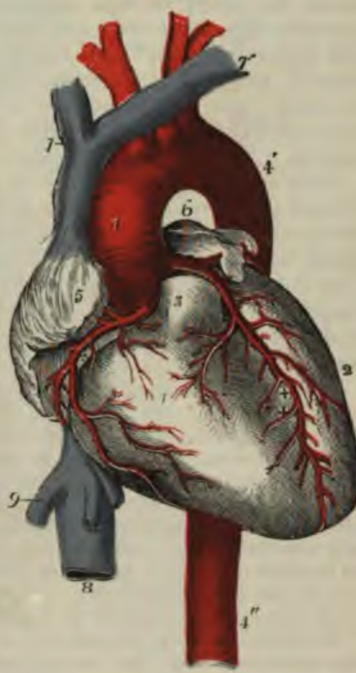
The *right coronary artery* arises from the anterior sinus of Valsalva; it comes forwards between the pulmonary artery and right auricular appendix, then runs obliquely in the auriculo-ventricular groove on the right side and the posterior aspect of the heart, until it reaches the line of separation between the two ventricles, where it divides into two branches. The smaller of these continues transversely in the groove between the left auricle and ventricle, approaching the termination of the transverse branch of the left coronary artery; while the other branch runs longitudinally downwards along the posterior interventricular groove, giving branches to each ventricle and to the septum between them.

In its course the right coronary artery gives, besides the offsets already noticed, small branches to the right auricle and ventricle, and also to the first part of the aorta and the trunk of the pulmonary artery. Along the right border of the ventricle a rather large branch usually descends towards the apex of the heart, and gives offsets, in its progress, to the anterior and posterior surfaces of the ventricle.

Fig. 231.—The heart and coronary arteries from before. (R. Quain.) $\frac{1}{3}$

The pulmonary artery has been cut short close to its origin in order to show the first part of the aorta: 1, right ventricle; 2, left ventricle; 3, root of the pulmonary artery; 4, ascending part of the arch of the aorta; 4′, descending part of the arch; between these is seen the transverse part from which the three large arteries take their origin; 4″, the descending thoracic aorta; 5, right, and 6, left auricular appendix; 7, 7′, right and left innominate veins, joining to form the superior vena cava; 8, the inferior vena cava; 9, one of the hepatic veins; +, placed in the right auriculo-ventricular groove, points to the right coronary artery; + +, placed in the anterior interventricular groove, points to the descending branch of the left coronary artery.

Fig 231.



The *left coronary artery* is generally rather larger than the preceding, and arises from the left posterior sinus of Valsalva. It passes behind and then to the left side of the pulmonary artery, appearing between that vessel and the left auricular appendage, where it divides into two branches. Of these, one pursues a transverse direction in the groove between the left ventricle and auricle, and approaches at the posterior aspect of the heart the transverse branch of the right coronary artery; the other branch, much the larger, descends on the anterior surface of the heart along the line of the interventricular groove, to the right of the apex.

The left coronary artery supplies some small branches at its commencement to the pulmonary artery, to the coats of the aorta, and to the left auricular appendage; its two branches also furnish throughout their course smaller offsets, which supply the left auricle, both ventricles, and the interventricular septum.

The two coronary arteries have fine anastomoses with one another on the surface of the heart, and they communicate also, by means of the small branches given to the coats of the great vessels, with the pericardial and bronchial arteries.

**Varieties.**—The coronary arteries have been observed in a few instances to commence by a common trunk, from which they diverged and proceeded to their usual destination. The existence of three coronary arteries is not a very rare occurrence, the third being small, and arising close by one of the others. Meckel,

**in one instance, observed four, the supplementary vessels appearing like branches of one of the coronary arteries springing directly from the aorta.**

### INNOMINATE ARTERY.

The innominate or brachio-cephalic artery (14 mm.), the largest of the vessels which proceed from the aorta, arises from the upper surface of the transverse portion of the arch, before the left carotid artery. From this point the vessel ascends obliquely towards the right, until it arrives opposite the sterno-clavicular articulation of that side, on a level with the upper margin of the clavicle, where it divides into the right subclavian and common carotid arteries. The place of bifurcation would, in most cases, be reached by a probe passed backwards through the interval between the sternal and clavicular portions of the sterno-mastoid muscle. The length of the artery usually ranges from one to two inches.

This artery, lying for the most part within the thorax, is placed behind the sternum, from which it is separated by the sterno-hyoid and sterno-thyroid muscles, by the remains of the thymus gland, and lower down by the left innominate vein, which crosses the artery at its root. The lower part of the innominate artery lies in front of the trachea, the upper against the pleura: on its left side is the left carotid artery below and the trachea above; and to the right is the corresponding innominate vein.

There are usually no branches arising from this vessel.

**Varieties.**—The length of the innominate artery sometimes exceeds two inches, and occasionally it measures less than one inch. Its place of division is a point of surgical interest, inasmuch as upon it in a great measure depends the accessibility of the innominate in the neck, and the length of the right subclavian artery. It is sometimes found dividing a considerable distance below the clavicle, and sometimes, but rather less frequently, above it. Though usually destitute of branches, this vessel supplies occasionally a thyroid branch, the *thyroidea ima*, and, in rare cases, the internal mammary artery, or a thymic branch, or a bronchial artery, which descends in front of the trachea.

The *thyroidea ima* is an occasional artery. When present, it usually arises from the innominate trunk, but in some instances it has been observed to come from the right common carotid artery, or from the aorta itself. More rarely it arises from the right internal mammary or subclavian. It varies greatly in size in different bodies, and compensates in various degrees for deficiencies or absence of the other thyroid arteries. It ascends to its destination in front of the trachea, and its presence might therefore complicate the operation of tracheotomy.

### COMMON CAROTID ARTERIES (I*).

POSITION AND RELATIONS—DIFFERENCE ON THE TWO SIDES.—The common carotid arteries of the right and left sides of the body are nearly similar in their course and position while they are in the neck; but they differ materially in their place of origin, and consequently in their length, and position at their commencement. On the right side the carotid artery commences at the root of the neck behind the upper part of the sterno-clavicular articulation, at the bifurcation of the innominate artery; but on the left side the carotid arises within the thorax, from the middle part of the arch of the aorta, very near the origin of the innominate artery.

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[*] This number indicates the order to which the artery belongs: see p. 349.

Fig. 232.

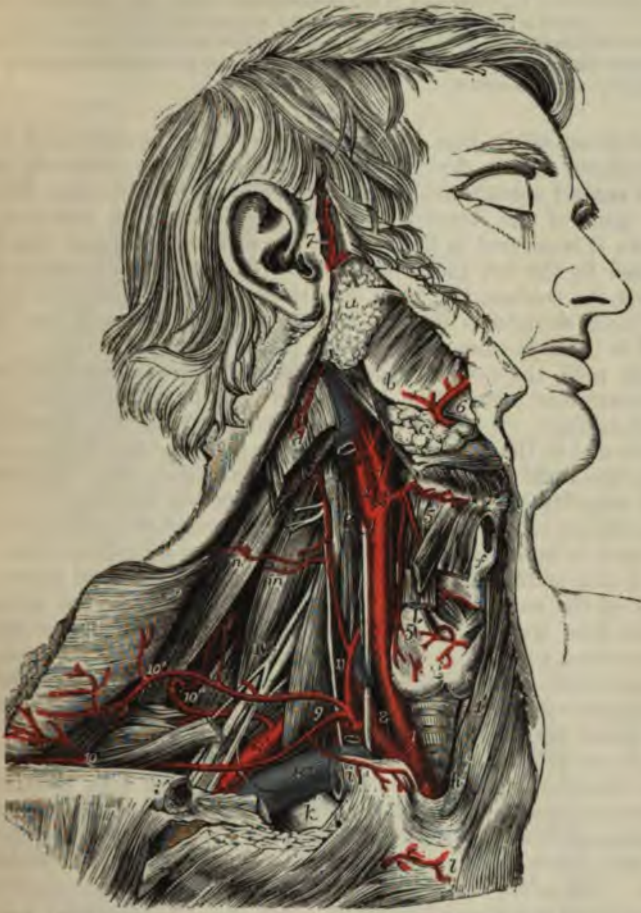


Fig. 232.—View of the right common carotid and subclavian arteries, with the origin of their branches and their relations. (R. Quain.) $\frac{1}{3}$

The sterno-mastoid, sterno-thyroid, sterno-hyoid, and omo-hyoid muscles have been in great part removed, the trapezius has been detached from the outer part of the clavicle and turned backwards, and the inner part of the clavicle has been removed : *a*, parotid gland near the place where the duct leaves it ; *b*, angle of the jaw and masseter muscle ; *c*, submaxillary gland ; *d*, upper part of the sterno-mastoid muscle ; *e*, hyoid bone ; *f*, thyroid cartilage ; *g*, isthmus of the thyroid body ; *h*, trachea ; *i*, *i'*, sawn ends of the clavicle, the portion between them having been removed ; *k*, first rib ; *l*, sternum ; *m*, scalenus medius ; *n*, levator anguli scapulæ ; *o*, deep surface of the trapezius ; *p*, on the rectus anticus major muscle, points to the pneumo-gastric nerve ; IV, uppermost of the nerves of the brachial plexus ; A, innominate artery ; 1, right common carotid artery ; 2, internal carotid ; 2', upper part of the internal jugular vein, which has been removed between 2', and *i* ; 3, and 4, external carotid ; 3 is placed at the origin of the superior thyroid artery ; 4, at that of the lingual ; farther up the vessel may be seen the separation of the sterno-mastoid twig and the facial and occipital branches from the main vessel ; 5, is placed on the thyro-hyoid muscle between the hyoid and laryngeal branches of 5', the superior thyroid artery ; 6, facial artery, passing over the base of the jaw ; 7, superficial temporal artery ; 8, first part, 8', third part of the subclavian artery ; 8'', subclavian vein separated from the artery by the scalenus anticus muscle ; 9, is placed on the

**scalenus anticus in the angle between the superficial cervical and suprascapular branches of the thyroid axis; 10, outer part of the suprascapular artery; 10′, superficial cervical artery; 10″, posterior scapular artery; 11, on the scalenus anticus, points to the inferior thyroid artery near the place where the ascending cervical artery is given off; the phrenic nerve lies on the muscle to the outside of the figure; at *i*, the suprasternal twig of the suprascapular artery is shown.**

The left carotid is thus as a whole longer than the right, and its first part is placed at some depth within the thorax. While *within the thorax*, the left carotid ascends obliquely behind and at some distance from the upper piece of the sternum and the sterno-hyoid and sterno-thyroid muscles; it is covered in front by the remains of the thymus gland, and is crossed by the left innominate vein. This part of the artery lies at first over the trachea, and then over the œsophagus, which, at the root of the neck, deviates a little to the left side; the thoracic duct is also behind it. The pneumo-gastric nerve is to its outer side.

*In the neck*, the common carotid artery of each side reaches from the sterno-clavicular articulation to the level of the upper border of the thyroid cartilage, where it divides into two great branches, of which one is distributed to the superficial parts of the head and to the face, and the other to the brain and eye. From their destination, these divisions are named respectively the *external* and *internal carotid arteries.*

The oblique course taken by the common carotid artery along the side of the neck is indicated by a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process of the temporal bone. At the root of the neck, the arteries of opposite sides are separated from each other only by a narrow interval, corresponding with the width of the trachea; but, as they ascend, they are separated by a much larger interval, corresponding with the breadth of the larynx and pharynx. The carotid arteries have the appearance of being placed farther back at the upper than at the lower part of the neck, owing to the forward projection of the larynx above.

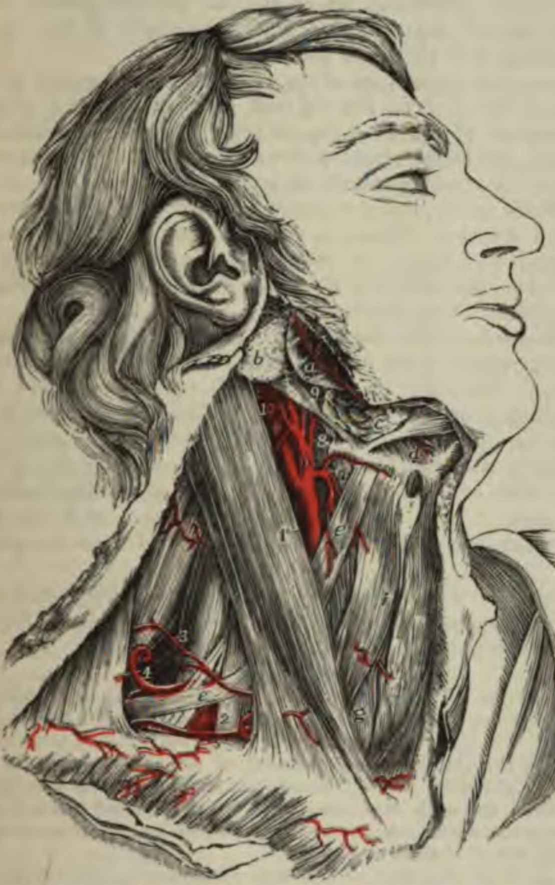
The common carotid artery is enclosed, together with the internal jugular vein and the pneumo-gastric nerve, in a common sheath, which is continuous with the deep cervical fascia; the nerve, artery and vein have each, however, a separate investment of connective tissue within the sheath. The artery is deeply placed at the lower part of the neck, but is comparatively superficial towards its upper end. It is covered below by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, in addition to the platysma and the layers of fascia between and beneath the muscles; and it is crossed opposite or near the lower margin of the cricoid cartilage by the omo-hyoid muscle. From this point upwards to its bifurcation, the vessel is covered by the common integument, the platysma and fascia, and in the natural condition of the parts also by the sterno-mastoid; but in the dissected subject, in consequence of the retraction of this muscle when the fascia is removed, the upper portion of the artery is exposed in a triangular space, the sides of which are formed by the posterior belly of the digastric, the anterior belly of the omo-hyoid, and the sterno-mastoid muscles, and which is known as the carotid triangle. In this space the artery is crossed by the small sterno-mastoid branch of the superior thyroid artery.

Posteriorly, the artery is supported by the cervical vertebræ, the longus colli and rectus anticus major muscles intervening. Hence the flow of blood through it may be commanded by pressure directed back-

against the vertebral column. The inferior thyroid artery crosses
l the carotid sheath.

rnally, the vessel is in relation with the trachea, the thyroid body
h often overlaps the artery), the larynx, the œsophagus, and the

Fig. 233.



3.— SUPERFICIAL DISSECTION OF THE RIGHT SIDE OF THE NECK TO SHOW THE CAROTID AND SUBCLAVIAN ARTERIES, &c. (from R. Quain). ⅓

gle of the jaw and masseter muscle ; *b*, parotid gland ; *c*, submaxillary gland ;
-hyoid muscle below the anterior belly of the digastric ; *e*, anterior, *e'*, posterior
the omo-hyoid ; *f*, sterno-hyoid ; *g*, sterno-thyroid ; 1, upon the sterno-mastoid
points by a line to the upper part of the common carotid artery ; 2, upon the
anticus, points to the third part of the subclavian artery ; 3, upon the scalenus
points to the superficial cervical artery crossing the nerves of the brachial plexus ;
rior scapular artery, passing under the levator scapulæ muscle ; 5, suprascapular
6, external carotid artery ; 6′, internal carotid artery ; 7, upon the thyro-hyoid
points to the superior thyroid artery giving superiorly its hyoid branch ; 8,
artery ; 9, placed on the stylo-hyoid muscle, indicates the facial artery ; 10,
l artery, from the root of which the small sterno-mastoid artery is given off ;
the occipital and the facial arteries, +, upon the posterior belly of the digastric
o the continuation of the external carotid artery before it passes under that muscle.

scalenus anticus in the angle between the superficial cervical and suprascapular branches of the thyroid axis; 10, outer part of the suprascapular artery; 10′, superficial cervical artery; 10″, posterior scapular artery; 11, on the scalenus anticus, points to the inferior thyroid artery near the place where the ascending cervical artery is given off; the phrenic nerve lies on the muscle to the outside of the figure; at *i*, the suprasternal twig of the suprascapular artery is shown.

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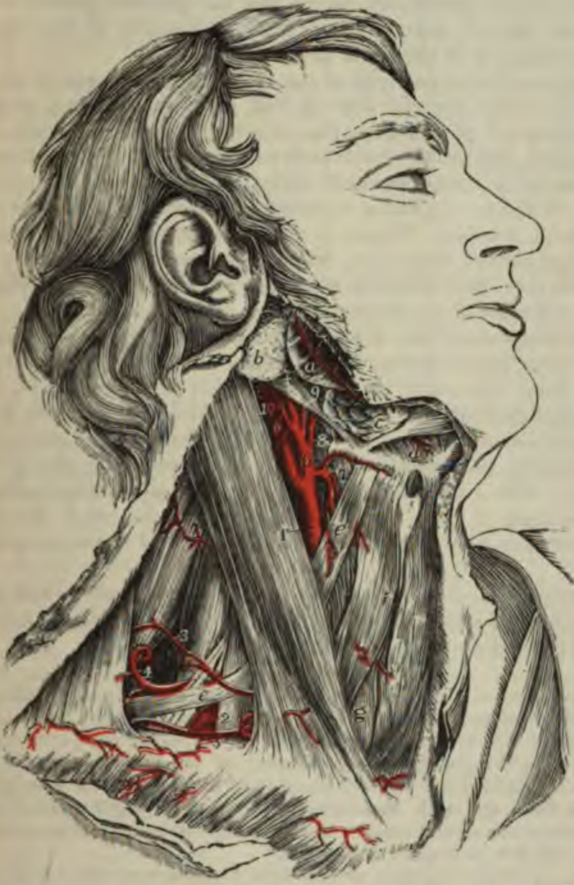

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1 the occipital and the facial arteries, +, upon the posterior belly of the digastric
o the continuation of the external carotid artery before it passes under that muscle.

## EXTERNAL CAROTID ARTERY (II).

Position and relations.—The external carotid artery, distributed mainly to the face and to the walls of the cranium, is smaller than the internal in young persons; but the two are nearly of equal size in adults. It reaches from the point of division of the common carotid, opposite the upper margin of the thyroid cartilage, to the neck of the lower jaw, where it divides into its two terminal branches, the superficial temporal and the internal maxillary. It diminishes rapidly as it ascends, owing to the number and size of the branches which spring from it.

At first the external carotid lies in front of and somewhat nearer the mesial plane than the internal carotid; but it soon becomes superficial to that artery, inclining slightly backwards as it ascends to its place of division. In its lower part the artery is covered by the platysma myoides and the fascia, and in the natural condition of the parts it is overlapped by the sterno-mastoid (*cf.* p. 362); in its upper part it is deeply placed, passing first beneath the stylo-hyoid and digastric muscles, and finally becoming embedded in the substance of the parotid gland. At its commencement it is in contact with the pharynx and hyoid bone; farther up it is separated by a portion of the parotid gland from the back of the ramus of the lower jaw and the stylo-maxillary ligament, and rests upon the styloid process and the stylo-pharyngeus muscle, which, with the glosso-pharyngeal nerve, are interposed between it and the internal carotid artery.

*Relation to veins.*—This artery has usually no companion vein, but in the parotid gland the *temporo-maxillary* trunk is superficial to it, and the anterior division of this, passing down to join the facial vein, is sometimes placed with the artery beneath the digastric muscle; below the digastric it is crossed by the *facial* and *lingual veins* as they pass backwards to open into the internal jugular.

*Relation to nerves.*—Close to the lower border of the digastric muscle the external carotid artery is crossed by the *hypoglossal nerve*, and at a short distance from its upper end, in the substance of the parotid gland, by the *facial nerve*. The *glosso-pharyngeal nerve* lies between it and the internal carotid; and the *superior laryngeal nerve* is on the inner side of both vessels.

Branches.—The branches of the external carotid artery are eight in number, viz., three directed forwards, the superior thyroid, the lingual, and the facial; two directed backwards, the occipital and posterior auricular; one on the inner side, the ascending pharyngeal; and the superficial temporal and internal maxillary, the two terminal branches into which the trunk divides.

In addition to the principal branches here enumerated, the external carotid gives off small offsets to the parotid gland, and to the masseter and internal pterygoid muscles.

**Varieties.**—The peculiarities in the origin of this vessel have been noticed along with the varieties of the common carotid artery. Absence of the external carotid artery has been met with in some rare cases, the several branches arising at intervals from a single trunk which represented the common and internal carotids. The branches are not unfrequently crowded together on the main stem, near the commencement, or at a higher point. Occasionally they take origin at regular distances in the whole length of the vessel. The usual number of branches may be diminished by the origin from another artery of one of the high as the hyoid bone, and occasionally much higher. It is found occasionally opposite the middle of the larynx, and, in rare instances, opposite the lower margin of the cricoid cartilage, or even lower. One case was observed by Morgagni, in which the carotid artery, measuring one inch and a half in length, divided at the root of the neck. The carotid artery has been found, as a very rare occurrence, to ascend in the neck without dividing into the two usual branches; either the external or the internal carotid being altogether wanting.

In a few recorded cases there was no common carotid artery, the external and internal carotids arising directly from the arch of the aorta (Malacarne, Power), or from the termination of the innominate artery (Kosinski, Bull. de la Soc. Anat. 1867).

*Relation to nerves.*—The pneumo-gastric nerve has been observed to descend in front of the artery (R. Quain).

*Occasional branches.*—The common carotid artery sometimes gives origin at its upper part to the superior thyroid or ascending pharyngeal artery; and in some rare cases, to a laryngeal or an inferior or accessory thyroid branch; also in a few instances, to the vertebral artery.

## SURGICAL ANATOMY OF THE COMMON CAROTID ARTERY.

As the common carotid does not in ordinary cases furnish any branch, a ligature may be applied to any part of the vessel except close to its commencement or termination. It is usually tied either immediately above or below the omo-hyoid muscle, the former situation being preferred if possible, since the artery is here more superficial, and the operation is consequently free from the difficulties caused by the muscles lower down. An incision is made along the anterior border of the sterno-mastoid muscle, through the integuments and fascia, and in doing this the communicating vein above referred to (p. 364), if present, must be avoided, or it may if necessary be secured with two ligatures and then divided. A small branch of the superior thyroid artery to the sterno-mastoid muscle will also probably be cut. The sterno-mastoid is next everted, and the anterior belly of the omo-hyoid displayed and drawn inwards. The sheath is now exposed and is to be opened over the artery near the trachea, in order to avoid the internal jugular vein, and it is best to insert the aneurism needle conveying the ligature on the outer side of the artery, for thus the vein and the pneumo-gastric nerve will be most effectually avoided. In opening the sheath the possible occurrence of a middle thyroid vein, crossing the artery at the level of the cricoid cartilage, should be borne in mind, and the descendens noni nerve, if it comes into view, must be carefully preserved. Should the jugular vein overlap the artery, as it sometimes does, especially at the lower part of the neck on the left side, it will be a source of much difficulty in completing the operation, and great caution will be required in passing the needle round the artery. If the operation is performed at the lower part of the neck, some fibres of the muscles will require to be cut across in order to lay the artery bare with facility; and the necessity for this step increases in approaching the clavicle. Near the clavicle also the transverse lower portion of the anterior jugular vein crosses the line of the incision.

*Collateral circulation.*—After ligature of the common carotid trunk the blood is conveyed to the cerebral and ophthalmic branches of the internal carotid from the vertebral arteries and the internal carotid of the opposite side, by means of the free communications existing between these vessels in the circle of Willis. The branches of the external carotid receive blood from the subclavian artery through the anastomoses of the superior and inferior thyroid arteries, and of the occipital with the deep cervical artery, and from the external carotid of the opposite side through the anastomoses of the two superior thyroid, lingual, facial, superficial temporal, and occipital arteries.

ramifies in the sterno-mastoid and the muscles attached to the thyroid cartilage, as well as in the platysma and neighbouring integument. The position of this branch with respect to the carotid artery is the only circumstance which gives it interest.

(*c*) The *laryngeal* branch, or *superior laryngeal artery* (v), proceeding inwards in company with the superior laryngeal nerve, and piercing the thyro-hyoid membrane. Before entering the larynx this branch is covered by the thyro-hyoid muscle. On reaching the interior of the larynx, it ramifies in the small muscles, the glands, and the mucous membrane of that organ.

(*d*) The *crico-thyroid* (vi), a small branch to be noticed on account of its position rather than its size. It crosses the membrane connecting the thyroid and cricoid cartilages, and communicates with a similar branch from the other side: hence it may be a source of hæmorrhage in the operation of laryngotomy.

**Varieties.**—*Size.*—The superior thyroid artery is frequently larger or smaller than usual. In either case the deviation from the accustomed size is accompanied by an opposite alteration in other thyroid arteries. It has been seen extremely small, ending in branches to the sterno-mastoid muscle and the larynx: total absence on one side has also been recorded. (See the observations on the inferior thyroid artery.)

*Origin.*—The superior thyroid is often transferred to the upper part of the common carotid artery; and it is occasionally conjoined with the lingual branch, or with that and the facial branch of the external carotid.

There are sometimes two superior thyroid arteries.

*Branches.*—The *hyoid* branch is frequently very small, or absent. The *laryngeal* branch often arises directly from the external carotid artery, rarely from the common carotid. Examples have occurred of this branch being of very large size, and terminating in the thyroid body. The laryngeal artery occasionally enters the larynx through a foramen in the thyroid cartilage, and it has also been observed to pass inwards below the cartilage. The *crico-thyroid artery* is sometimes of considerable size.

**2. Lingual artery** (iv).—The lingual artery (fig. 237, p. 376) arises from the fore part of the external carotid, between the superior thyroid and facial arteries, and generally opposite the great cornu of the hyoid bone. From its origin it first ascends for a short distance, and then bends sharply downwards, forming a loop which is crossed by the hypoglossal nerve. Disappearing beneath the digastric and stylo-hyoid muscles, it is continued forwards along the upper border of the great cornu of the hyoid bone, and under cover of the hyo-glossus, to near the anterior border of that muscle; it there ascends almost perpendicularly to the under surface of the tongue, along which it is continued forwards to the tip, receiving the name of the *ranine artery*. The lingual artery lies upon the middle constrictor of the pharynx and the genio-glossus muscle; and the hypoglossal nerve, which courses forwards on the outer surface of the hyo-glossus, is placed above the level of the artery, except at the anterior border of the muscle, where the artery ascends and issues above the position of the nerve.

*Branches.*—(*a*) The *hyoid* branch runs along the upper border of the hyoid bone, and supplies the contiguous muscles and skin, anastomosing with the artery of the opposite side, and with the hyoid branch of the superior thyroid artery.

(*b*) The *dorsal artery of the tongue*, which is often replaced by several smaller offsets. This arises from the deep portion of the lingual artery, beneath the hyo-glossus muscle, and ascends to supply the mucous membrane of the dorsum, and the substance of the tongue, as well as the tonsil, ramifying as far back as the epiglottis, and communicating around the foramen cæcum with the corresponding branch of the opposite side.

(c) The *sublingual* branch. Taking origin at the anterior margin of the hyo-glossus, this branch runs forwards between the genio-glossus muscle and the sublingual gland. It supplies the substance of the gland, and gives branches to the mylo-hyoid and other muscles connected with the lower jaw. Small branches are also distributed to the mucous membrane of the mouth and the inside of the gum, and a considerable offset anastomoses across the middle line with the artery of the other side.

(d) The *ranine artery* passes forwards with a tortuous course, giving numerous branches as it proceeds, and being for the most part embedded in the substance of the tongue between the genio-glossus and inferior lingualis muscles. Near the tip of the tongue it communicates with the opposite ranine artery in a small loop (Krause), but with this exception the right and left arteries do not form other than capillary anastomoses. In the last part of its course the ranine artery lies quite superficially, at the side of the frænum.

**Varieties.**—The lingual artery is often united at its origin with the facial; less frequently with the superior thyroid; and the three vessels occasionally arise by a common trunk. Instead of passing beneath the hinder border of the hyo-glossus the artery sometimes pierces the origin of the muscle. The lingual artery has been seen replaced entirely or in large part by a branch of the internal maxillary, or of the submental branch of the facial. The *hyoid* branch is often absent; and it appears that this branch varies in size inversely with the hyoid branch of the superior thyroid artery. The *sublingual* branch is sometimes derived from the facial artery, and then perforates the mylo-hyoid muscle. The lingual artery has been observed to give off, as unusual branches, the superior laryngeal, the submental, and the ascending palatine.

**Surgical anatomy.**—The lingual artery may be tied either in the carotid triangle, before it passes under the digastric muscle, or farther forwards, while it is beneath the hyo-glossus; preferably in the latter situation, since its place of origin is subject to variation and its relation to the tip of the great cornu of the hyoid bone is therefore not constant. To reach the artery in the submaxillary triangle, a curved incision, reaching from a point a little outside the symphysis nearly to the angle of the lower jaw and descending in the middle to the hyoid bone, is made through the integuments, the platysma and the deep fascia, and the submaxillary gland is drawn upwards, when the intermediate tendon of the digastric is brought into view, together with portions of its two bellies, and the lower end of the stylo-hyoid muscle. Crossing the angle formed by the two bellies of the digastric the hypoglossal nerve is seen, accompanied by the ranine vein, and passing forwards beneath the hinder border of the mylo-hyoid; and some fibres of the last muscle may be cut if necessary. By then dividing carefully the hyo-glossus muscle in the interval between the hypoglossal nerve and the tendon of the digastric the lingual artery is exposed and may be secured. The facial vein is frequently seen in the posterior angle of the wound, and may be injured if the primary incision is made too freely.

**3. Facial artery (iv).**—The facial artery (external maxillary), taking origin a little above the lingual, is at first directed upwards, beneath the digastric and stylo-hyoid muscles, and enters the hinder part of the submaxillary triangle; it then runs horizontally forwards under cover of the base of the lower jaw, resting on the mylo-hyoid muscle, and being lodged in a groove on the deep surface of the submaxillary gland. Emerging from beneath the gland it turns sharply upwards and crosses the base of the jaw immediately in front of the masseter, being covered only by the platysma and the integuments: here the pulsation of the artery is easily felt, and the circulation through it may be controlled by pressure against the bone; at this point also the vessel may be readily ligatured.

Fig. 235.

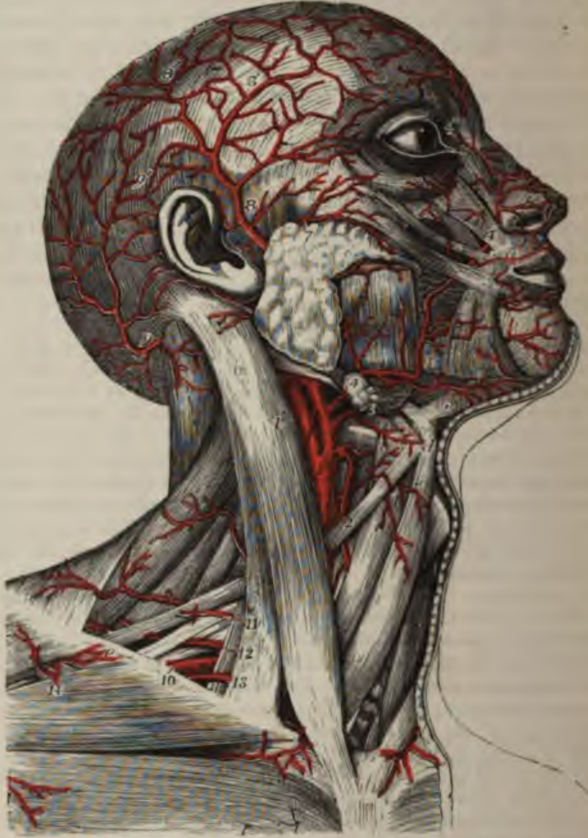


Fig. 235.—Superficial view of the arteries of the head and neck (reduced from Tiedemann). $\frac{1}{3}$

*a*, orbicularis oris; *b*, sterno-mastoid; *c*, parotid gland near its duct; *d*, hyoid bone; *e*, clavicle; 1, trunk of the common carotid artery near its division into the external and internal carotids; 1′, internal carotid; 2, placed on the anterior belly of the omo-hyoid muscle, points to the superior thyroid artery; 3, lingual artery and its hyoid branch; 4, placed on the submaxillary gland at the place where the facial artery sinks beneath it, and again where the artery turns over the lower jaw; 4′, termination of the facial artery by division into the angular and lateral nasal branches; 4″, is between the frontal and nasal branches of the ophthalmic artery; 5, submental branch of the facial artery; 6, inferior labial branch; 7, transverse facial artery; 8, superficial temporal artery, passing over the zygoma and distributed by 8′, 8′, its anterior and posterior divisions on the surface of the cranium; 9, occipital artery; 9′, its distribution and anastomoses with the superficial temporal and posterior auricular arteries; 10, third part of the subclavian artery; 11, superficial cervical, and 12, posterior scapular arteries; 13, suprascapular artery; 14, acromio-thoracic branch of the axillary artery.

ı the side of the face the artery ascends obliquely, passing near the e of the mouth and by side of the nose, to the inner canthus of the where it ends by inosculating with the nasal branch of the ophnic artery. In this part of its course the artery is exceedingly ious, a circumstance connected with the great mobility of the parts on h it rests. It is crossed by the risorius and the zygomatic muscles; s upon the buccinator, the levator anguli oris and the levator labii rioris (sometimes under the last muscle); and near its ending it is dded in the fibres of the levator labii superioris alæque nasi.

e *facial vein* is to the outer side of the artery and separated from it considerable interval in the face; at the base of the jaw the vein is to the artery; and in the neck the vein is more superficial, being rated from the artery by the submaxillary gland.

anches of the *facial nerve* cross the vessel; and the *infraorbital* e is beneath it, separated by the fibres of the elevator of the upper lip.

. *Cervical branches.*—The following branches are derived from acial artery below the jaw :—

) The *inferior* or *ascending palatine artery*, a considerable branch, nds between the stylo-glossus and stylo-pharyngeus muscles, and then een the internal pterygoid and the wall of the pharynx, to near the of the skull, giving small branches to the surrounding muscles, to tonsil, and to the Eustachian tube. Meeting the levator palati, it s downwards and passes with that muscle above the upper border of superior constrictor into the soft palate, where it is distributed to the ous membrane, the glands, and the muscles, and anastomoses with artery of the opposite side. The place of this artery in the palate is uently taken by the ascending pharyngeal.

b) The *tonsillar* branch ascends on the outer side of the stylo-glossus cle, and, penetrating the superior constrictor of the pharynx, inates in small vessels upon the tonsil and the side of the tongue r its root. This branch is often represented by one or more twigs ı the inferior palatine artery.

) The *glandular* branches are several short vessels which enter the tance of the submaxillary gland, while the facial artery is in contact it. Small twigs are also furnished from this part of the artery to the -hyoid, internal pterygoid, and masseter muscles.

) The *submental* branch is the largest arising from the facial in the . Leaving the artery near the point at which it turns upwards to face, this branch runs forwards below the base of the jaw, on the ce of the mylo-hyoid muscle, and gives branches to the surrounding les and the integuments, as well as others which perforate the mylo-l to anastomose with the sublingual artery. Much diminished in t turns over the border of the jaw near the symphysis, and terminates anches to the depressor labii inferioris and levator menti muscles, the other structures of the chin and lower lip, forming anastomoses the inferior labial and mental arteries, and with the corresponding ch of the opposite side.

*Facial branches.*—From the outer side of the artery in its facial on small offsets proceed which are distributed to the muscles—eter, buccinator, &c., and anastomose with the transverse facial, al, and infraorbital arteries. The larger branches are directed rds, and are as follows :—

) The *inferior labial* branch arises soon after the facial artery has turned over the lower border of the maxilla, and, running forwards beneath the depressor anguli oris, distributes branches to the skin and muscles of the lower lip, anastomosing with the inferior coronary, submental, and mental arteries. This is frequently an offset of the following branch.

(*b*) The *coronary artery of the lower lip* (v). Arising at the outer border of the depressor anguli oris, this branch takes a transverse and tortuous course beneath that muscle, and between the orbicularis oris and the mucous membrane near the free margin of the lip, and inosculates with the corresponding artery of the opposite side. Small twigs from it supply the orbicular and depressor muscles, the glands, and other structures of the lower lip; and some descend towards the chin to communicate there with other branches.

(*c*) The *coronary artery of the upper lip* (v), arises beneath the zygomaticus major muscle. It runs across between the muscle and mucous membrane of the upper lip, and inosculates with its fellow of the opposite side. In addition to supplying the whole thickness of the upper lip, it gives two or three small branches to the nose. One of these, named the *artery of the septum*, runs along the border of the columna nasi, on which it ramifies as far as the point of the nose.

(*d*) The *lateral nasal artery*, often replaced by two or three smaller branches, turns inwards to the side of the nose, over which it ramifies, sending offsets to the ala and the dorsum. It anastomoses with the nasal branch of the ophthalmic, with the artery of the septum, and with the corresponding artery of the opposite side.

(*e*) *Angular artery*. Under this name is recognised the slender terminal part of the facial artery, which inosculates at the inner side of the orbit with the nasal branch of the ophthalmic artery.

**Varieties**.—*Origin*.—The facial artery frequently arises by a common trunk with the lingual. Occasionally it arises above its usual position, and then descends beneath the angle of the jaw to assume its ordinary course.

*Size*.—This artery varies much in size, and in the extent of its distribution. It has been observed, very rarely, however, to end as the submental, not reaching the side of the face: in some cases it supplies the face only as high as the lower lip; and it often fails to supply the lateral nasal and angular branches. The deficiency of the facial artery is most frequently compensated for by an enlargement of the nasal branch of the ophthalmic at the inner side of the orbit; occasionally by branches from the transverse facial, or internal maxillary artery. As a rare occurrence it has been found larger than usual, and replacing the nasal and frontal branches of the ophthalmic.

*Branches*.—The *ascending palatine artery* is in some instances transferred to the external carotid. This branch varies in size and the extent to which it reaches. Not unfrequently it is expended without furnishing any branch to the soft palate. When it is thus reduced in size, the pharyngeal artery takes its place in the soft palate. The *submental* branch has been observed to take its rise from the sublingual artery. On the other hand, the facial artery, instead of the lingual, sometimes furnishes the branch which supplies the sublingual gland. The two *coronary arteries* sometimes arise by a common trunk; and one or other of these vessels may be smaller than usual, the corresponding artery of the opposite side being enlarged and supplying the deficiency.

**4. Occipital artery** (iv).—The occipital artery, arising from the posterior part of the external carotid, usually opposite the facial or a little higher up, is directed upwards and backwards, beneath the posterior belly of the digastric muscle, to the interval between the transverse process of the atlas and the mastoid process of the temporal bone. Here it turns backwards along the skull, lying in the occipital groove of the temporal bone, internal to the mastoid process and the sterno-mastoid, splenius, trachelo-mastoid and digastric muscles, and resting on the superior oblique and complexus. Lastly, issuing between the cranial attachments of the sterno-mastoid and trapezius, it ascends beneath the integument on the back of the head, accompanied by the great occipital nerve, and divides into branches, which are distributed upon the upper and back part of the cranium. While in the neck, the occipital artery crosses over the internal carotid artery, the pneumo-gastric and spinal accessory nerves, and the internal jugular vein; and the hypoglossal nerve winds from behind forwards over it at its origin.

*Branches.*—(*a*) Small *muscular* offsets to the digastric, stylo-hyoid, splenius, and trachelo-mastoid muscles, and one of larger size to the sterno-mastoid. This *sterno-mastoid* branch is very constant: arising generally from the occipital artery close to its commencement, but not unfrequently from the trunk of the external carotid, it turns downwards over the loop formed by the hypoglossal nerve, and enters the muscle in company with the spinal accessory nerve.

(*b*) A small twig, the *mastoid* branch, enters the skull through the mastoid foramen, and ramifies in the diploe and the dura mater.

(*c*) The *cervical* branch, *ramus cervicalis princeps*, is distributed to the muscles of the upper and back part of the neck. Descending a short way, this vessel divides into a superficial and a deep branch. The former ramifies beneath the splenius, sending offsets through that muscle to the trapezius; while the deep branch passes beneath the complexus, and anastomoses with branches of the vertebral artery, and with the deep cervical artery. The size of this branch varies very much.

(*d*) The *superficial* or *cranial* branches pursue a tortuous course between the integument and the occipito-frontalis muscle; and in proceeding upwards on the skull they separate into diverging branches, which anastomose freely with one another, as well as with the branches of the opposite artery, of the posterior auricular artery, and of the superficial temporal artery.

**Varieties.**—*Origin.*—The occipital artery is occasionally derived from the internal carotid, or from the ascending cervical branch of the inferior thyroid—an offset of the subclavian artery.

*Course.*—The occipital artery sometimes passes outside the trachelo-mastoid instead of internal to it. The chief portion of the vessel has been found to pass over the sterno-mastoid muscle, only a small artery being placed in the usual position. In a few instances the artery has been seen to turn backwards below the transverse process of the atlas.

*Branches.*—A *posterior meningeal* branch is sometimes given from the occipital artery, ascending on the internal jugular vein, and passing through the jugular foramen to ramify in the dura mater of the posterior fossa of the base of the skull. The *parietal* branch (Cruveilhier) is an occasional offset which springs from one of the terminal branches of the occipital artery, and enters the skull by the parietal foramen to be distributed to the surrounding dura mater. The occipital artery sometimes gives origin to the stylo-mastoid branch (normally an offset of the posterior auricular), to the posterior auricular artery, or to the ascending pharyngeal artery.

**5. Posterior auricular artery** (v).—The posterior auricular artery arises from the external carotid a little higher up than the occipital. It turned over the lower border of the maxilla, and, running forwards beneath the depressor anguli oris, distributes branches to the skin and muscles of the lower lip, anastomosing with the inferior coronary, submental, and mental arteries. This is frequently an offset of the following branch.

(*b*) The *coronary artery of the lower lip* (V). Arising at the outer border of the depressor anguli oris, this branch takes a transverse and tortuous course beneath that muscle, and between the orbicularis oris and the mucous membrane near the free margin of the lip, and inosculates with the corresponding artery of the opposite side. Small twigs from it supply the orbicular and depressor muscles, the glands, and other structures of the lower lip; and some descend towards the chin to communicate there with other branches.

(*c*) The *coronary artery of the upper lip* (V), arises beneath the zygomaticus major muscle. It runs across between the muscle and mucous membrane of the upper lip, and inosculates with its fellow of the opposite side. In addition to supplying the whole thickness of the upper lip, it gives two or three small branches to the nose. One of these, named the *artery of the septum*, runs along the border of the columna nasi, on which it ramifies as far as the point of the nose.

(*d*) The *lateral nasal artery*, often replaced by two or three smaller branches, turns inwards to the side of the nose, over which it ramifies, sending offsets to the ala and the dorsum. It anastomoses with the nasal branch of the ophthalmic, with the artery of the septum, and with the corresponding artery of the opposite side.

(*e*) *Angular artery.* Under this name is recognised the slender terminal part of the facial artery, which inosculates at the inner side of the orbit with the nasal branch of the ophthalmic artery.

**Varieties.**—*Origin.*—The facial artery frequently arises by a common trunk with the lingual. Occasionally it arises above its usual position, and then descends beneath the angle of the jaw to assume its ordinary course.

*Size.*—This artery varies much in size, and in the extent of its distribution. It has been observed, very rarely, however, to end as the submental, not reaching the side of the face: in some cases it supplies the face only as high as the lower lip; and it often fails to supply the lateral nasal and angular branches. The deficiency of the facial artery is most frequently compensated for by an enlargement of the nasal branch of the ophthalmic at the inner side of the orbit; occasionally by branches from the transverse facial, or internal maxillary artery. As a rare occurrence it has been found larger than usual, and replacing the nasal and frontal branches of the ophthalmic.

*Branches.*—The *ascending palatine artery* is in some instances transferred to the external carotid. This branch varies in size and the extent to which it reaches. Not unfrequently it is expended without furnishing any branch to the soft palate. When it is thus reduced in size, the pharyngeal artery takes its place in the soft palate. The *submental* branch has been observed to take its rise from the sublingual artery. On the other hand, the facial artery, instead of the lingual, sometimes furnishes the branch which supplies the sublingual gland. The two *coronary arteries* sometimes arise by a common trunk; and one or other of these vessels may be smaller than usual, the corresponding artery of the opposite side being enlarged and supplying the deficiency.

**4. Occipital artery** (**iv**).—The occipital artery, arising from the posterior part of the external carotid, usually opposite the facial or a little higher up, is directed upwards and backwards, beneath the posterior belly of the digastric muscle, to the interval between the transverse ributed to the gland; 18, superior thyroid artery, anastomosing on the gland with the rior thyroid; 19, lingual artery, brought into view by the removal of part of the hyo-sus muscle; 20, facial artery, giving off the palatine, tonsillar and submental branches; inferior, 22, superior coronary artery; 23, occipital artery; 24, posterior auricular ry; 25, superficial temporal artery; 26, internal maxillary artery; 27, transverse al, in this instance double, and given off directly by the external carotid artery.

ends under cover of the parotid gland, resting on the styloid process the temporal bone and being crossed by the facial nerve, reaches the ove formed by the cartilage of the ear with the mastoid process, and re divides into two terminal branches, auricular and mastoid, which distributed to the auricle and to the scalp behind and above the ear.

*Branches.*—(*a*) Small branches to the parotid gland, and to the astric and styloid muscles.

(*b*) The *stylo-mastoid* branch, long and slender, enters the foramen of same name in the temporal bone in company with the facial nerve. sends small branches backwards to the mastoid cells, and others for-rds to the stapedius muscle and the tympanum. One of the latter nches is constantly found in young subjects to form, with the tym-nic branch of the internal maxillary artery, a vascular circle around margin of the tympanic membrane, from which delicate offsets are tributed to that structure. The continuation of the stylo-mastoid nch is a minute twig which runs forwards in the aqueduct of Fallopius d anastomoses with the petrosal branch of the large middle meningeal ery. The stylo-mastoid branch frequently arises from the occipital ery.

c) The *auricular* branch ascends behind the ear, passing beneath the ahens auriculam which it supplies, and is expended mainly in offsets the auricle, a small branch being prolonged to the integument of the der part of the temporal region, and anastomosing with the posterior nch of the superficial temporal artery. The offsets to the auricle two or more in number; they supply the inner surface of the pinna, to a great extent also the outer surface by means of branches ch perforate the cartilage or turn over its margin.

d) The *mastoid* or *occipital* branch is directed backwards over the rtion of the sterno-mastoid, supplies the occipitalis muscle and over-g integument, and anastomoses with the occipital artery.

**arieties.**—The posterior auricular artery is frequently very small, and has seen to end in the stylo-mastoid branch. On the other hand it may be r than usual and compensate for a deficiency of the occipital or superficial poral artery. It is often a branch of the occipital.

**Ascending pharyngeal artery** (v).—This artery, the smallest nch of the external carotid that has received a distinctive designation, long straight vessel which arises most commonly from half an inch an inch above the beginning of the external carotid, and runs upwards the base of the skull on the mesial side of the internal carotid artery, ween that and the wall of the pharynx.

*Branches.*—These are very small, and may be divided into three sets, pharyngeal branches, prevertebral branches, and meningeal branches.

(*a*) The *pharyngeal* branches pass inwards, for the most part to the arynx. One or two small and variable branches ramify in the middle d inferior constrictor muscles, and anastomose with the superior yroid artery. Higher up than these is a larger and more regular branch, which runs upon the upper constrictor, and sends small ramifications to the Eustachian tube, to the tensor and levator palati muscles, and to the tonsil.

The last mentioned, or *palatine* branch, is sometimes of considerable size, and supplies the soft palate, taking the place of the inferior palatine branch of the facial artery, which in such cases is small. It divides into an anterior and a posterior twig, both of which anastomose in the middle line, with their fellows of the opposite side.

Fig. 237.

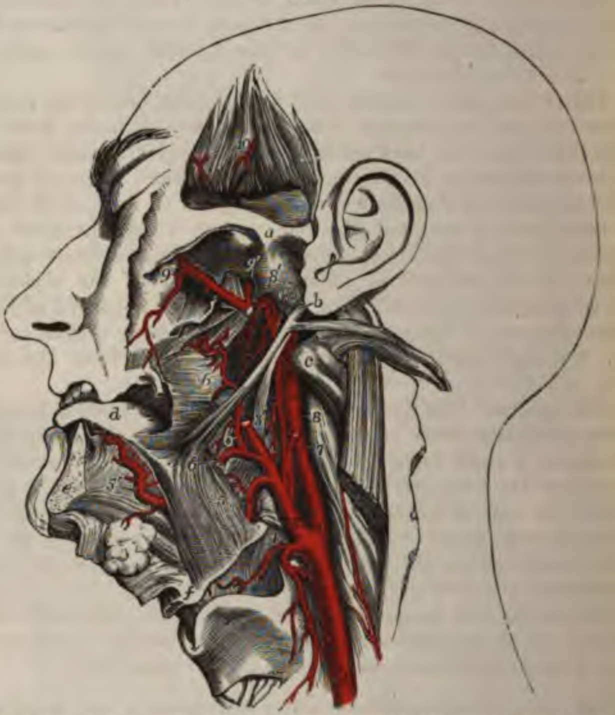


Fig. 237.—THE LINGUAL AND ASCENDING PHARYNGEAL ARTERIES (from R. Quain). ½

The left half of the lower jaw has been removed, with the external and internal pterygoid muscles, and the temporal muscle has been turned up from within the zygoma; *a*, base of the zygoma, above the glenoid cavity; *b*, placed on the lobule of the ear, points by a line to the styloid process, from which the stylo-glossus and stylo-pharyngeus are seen passing downwards and forwards, while the stylo-hyoid, detached from the hyoid bone, is thrown backwards with the digastric muscle; *c*, transverse process of the atlas; *d*, upper surface of the tongue; *e*, sawn surface of the lower jaw; *f*, hyoid bone; 1, common carotid artery; 2, internal carotid artery; 3, external carotid artery; 3', placed on the stylo-pharyngeus muscle, points by a line to the upper part of the external carotid artery, divided where it enters the parotid gland; 4, superior thyroid artery, its laryngeal branch passing upon the thyro-hyoid membrane; 5, lingual artery, about to pass beneath the hyo-glossus muscle; 5', placed on the genio-glossus, points to the continuation of the lingual artery as the ranine; 6, facial artery cut short; 6', its inferior palatine branch; 7, occipital artery cut short; 8, ascending pharyngeal artery; 8', its upper part turning down upon the pharynx; 9, internal maxillary artery as it passes into the spheno-maxillary fossa, and gives the posterior dental and the infraorbital arteries; 9', middle meningeal artery; 10, placed on the deep surface of the temporal muscle, which some cut branches of the deep temporal arteries.

) The *prevertebral* branches, small and irregular, are distributed to longus colli and recti antici muscles, to the upper cervical ganglion ae sympathetic nerve and some of the cranial nerves as they issue from skull, and to lymphatic glands. Some of them anastomose with the nding cervical branch of the subclavian artery.

:) The *meningeal* branches are terminal twigs, which pass through foramen lacerum, jugular foramen, and anterior condylar foramen, to in the dura mater.

**arieties.**—This artery varies greatly in its place of origin from the external tid. It sometimes springs from the occipital, from the internal carotid, or n the bifurcation of the common carotid artery. It is occasionally double, in a few cases three arteries have been seen.

'. **Superficial temporal artery** (**iv**).—The superficial temporal ry, one of the two branches into which the external carotid finally ides a little below the condyle of the lower jaw, continues upwards direction of the main trunk, while the other branch (the internal xillary) curves forwards under cover of the jaw. The temporal artery t first embedded in the substance of the parotid gland, in the interval ween the meatus of the ear and the condyle of the lower jaw. Thence ascends over the posterior root of the zygoma, against which it may dily be compressed. From this point onwards, it lies close beneath skin, upon the temporal fascia; and, a variable distance above the goma, it divides into two branches, which again subdivide and ramify neath the integument on the side and upper part of the head.

*Branches.*—Besides several small offsets to the parotid gland, some anches to the articulation of the lower jaw, and one or two to the asseter muscle, the temporal artery gives off the following branches:—

(*a*) The *transverse facial artery.* This branch arises while the mporal artery is deeply seated in the parotid gland, beneath the iterior part of which it runs nearly horizontally forwards; placed above e parotid duct, it rests on the masseter muscle, and is accompanied by me transverse branches of the facial nerve. It gives small vessels to e parotid gland, the masseter muscle, and the neighbouring integuent; and divides into three or four branches, which are distributed to e side of the face, anastomosing with the buccal, infraorbital and facial teries.

(*b*) The *middle temporal* branch arises close above the zygoma. Imediately perforating the temporal fascia, it ascends in a slight groove the squamous part of the temporal bone and gives branches to the mporal muscle, which communicate with the deep temporal branches the internal maxillary artery.

(*c*) The *anterior auricular* branches, two or more in number, superior d inferior, are distributed to the fore part of the pinna, the lobule of e ear, and a part of the external meatus, anastomosing with the ramifitions of the posterior auricular artery.

(*d*) The *orbital* branch, sometimes arising from the middle temporal, ns forwards above the zygoma to supply the outer part of the orbicuis palpebrarum muscle and the skin. This branch varies much in size, d it is not unfrequently absent.

(*e*) The *anterior temporal* branch is one of the two terminal branches of e temporal artery. This vessel inclines forwards as it ascends over the mporal fascia, and ramifies extensively upon the fore part of the head, supplying the orbicular and occipito-frontal muscles, the pericranium, and the skin, and communicating with the supraorbital and frontal branches of the ophthalmic artery, as well as with offsets of the posterior branch. On the upper part of the cranium the branches of this artery are directed from before backwards. When it is desired to take blood from the temporal artery, the anterior temporal branch is selected for the operation.

(*f*) The *posterior temporal* branch, which is usually larger than the anterior, ascends on the side of the head, over the temporal fascia; its branches ramify freely in the coverings of the cranium, both upwards to the vertex, where they communicate with the corresponding vessel of the opposite side, and backwards to join with the occipital and posterior auricular arteries.

**Varieties.**—The terminal branches of the temporal artery are frequently very tortuous, especially in aged persons. The *anterior temporal* branch is sometimes larger than the posterior, and, passing backwards over the vertex of the head, communicates with the occipital. The *transverse facial artery* varies in size: occasionally it is much larger than usual, and takes the place of a defective facial artery. It is frequently double. In many instances the transverse artery arises directly from the external carotid (fig. 236). The *orbital* branch is sometimes of considerable size, and extends into the eyelids; it has been seen to communicate with the supraorbital artery and supply a large part of the forehead (Cruveilhier).

**8. Internal maxillary artery (iii).**—The internal maxillary or deep facial artery, the larger of the two terminal branches of the external carotid, is concealed by the parotid gland at its origin below the condyle of the jaw; it curves horizontally forwards between the jaw and the internal lateral ligament of the temporo-maxillary joint, then passes obliquely forwards and upwards either on the outer or inner surface of the external pterygoid, and opposite the interval between the two heads of that muscle, bends inwards to the spheno-maxillary fossa, where it ends by breaking up into a number of branches.

To facilitate the arrangement of its numerous branches, this artery may be divided into three parts, viz., 1, the part between the jaw and the internal lateral ligament; 2, the part in contact with the external pterygoid muscle; and, 3, the part in the spheno-maxillary fossa.

A. *Branches of the first part.*—(*a*) The *deep auricular* branch, of small size, and often arising in common with the next offset, perforates the anterior wall of the external auditory meatus, and supplies the skin and outer part of the tympanic membrane.

(*b*) The *tympanic* branch, also small and variable in its origin, enters the tympanum by the fissure of Glaser, and is distributed to the structures within that cavity and the tympanic membrane, anastomosing with the stylo-mastoid artery (see p. 375).

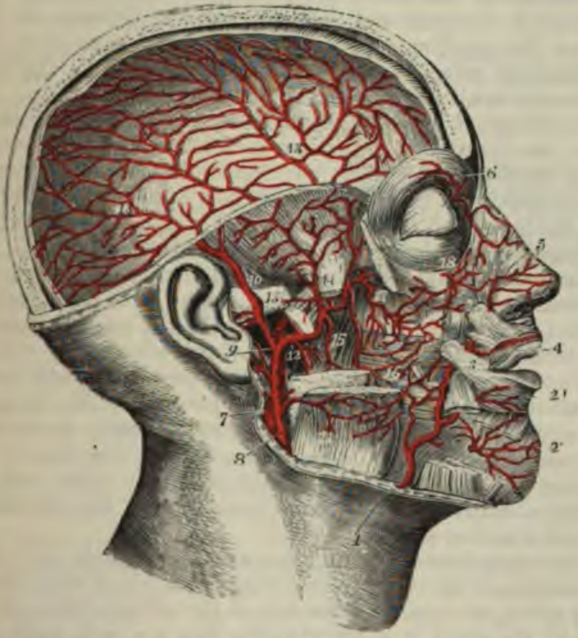
(*c*) The *middle* or *great meningeal artery* (v), the largest branch of the internal maxillary, passes directly upwards under cover of the external pterygoid muscle, between the two roots of the auriculo-temporal nerve, and enters the skull by the foramen spinosum of the sphenoid bone. Within the cranium, it ascends towards the anterior inferior angle of the parietal bone, and divides into two branches, which subdivide and ramify in deep arborescent grooves on the inner surface of the calvaria, passing upwards on the parietal bone as high as the vertex, forwards to the bone, and backwards to the occipital bone.

ıediately on entering the cranium the meningeal artery gives
twigs to the Gasserian ganglion and to the dura mater near the
ırcica, and a small *petrosal* branch which enters the hiatus Fallopii,
astomoses with the stylo-mastoid branch of the posterior auricular
It also anastomoses with branches of the ophthalmic artery.

The *small meningeal artery*, usually arising from the preceding,
the skull through the foramen ovale, to supply the Gasserian
ɔn and the dura mater in the middle fossa.

The *inferior dental artery*, passing downwards, enters the dental
vith the inferior dental nerve, and subsequently escapes on the face
mental foramen. As it enters the canal, it gives off the *mylo-hyoid*

Fig. 238.



238.—Deep dissection of the head and face, to show the internal maxillary artery and its branches (from Tiedemann). $\frac{1}{3}$.

ight half of the calvaria, the zygomatic arch, and the upper half of the ramus of
er jaw, with the external pterygoid muscle, have been removed; some of the
ial muscles of the face have been divided, and the internal pterygoid and buc-
muscles are exposed: 1, facial artery, rising over the edge of the lower jaw; 2,
coronary artery; 2′, mental branch of the inferior dental artery; 3, facial artery
d; 4, superior coronary; 5, lateral nasal; 6, frontal branch of the ophthalmic
rom which the nasal artery is seen descending on the nose; 7, internal carotid
8, external carotid; 9, division of the external carotid into superficial temporal
rnal maxillary arteries; 10, superficial temporal; 11, masseteric branch of the
carotid artery; 12, internal maxillary artery, at the origin of its inferior dental
13, on the base of the zygoma, points to the origin of the middle meningeal branch,
the dura mater above, to its distribution; 14, on the lower part of the temporal
is between the deep temporal branches of the artery; 15, pterygoid branches;
al artery; 17, posterior dental, and deepest part of the internal maxillary artery
t enters the spheno-maxillary fossa; 18, branches of the infraorbital artery
upon the face.

branch, which, with the nerve bearing the same name, runs in a groove on the inner surface of the jaw, below the dental foramen, and ramifies on the under surface of the mylo-hyoid muscle. In its course through the bone, the inferior dental artery gives off small offsets, which ascend to enter the minute apertures in the extremities of the fangs of the teeth, and supply the pulp of each; before emerging at the mental foramen, it sends forwards a branch which supplies the incisor teeth and communicates with its fellow of the opposite side. The terminal or mental branch anastomoses with the inferior coronary, inferior labial, and submental arteries.

(*f*) A small branch, arising either from the inferior dental artery or from the internal maxillary trunk, descends with the lingual nerve, and is distributed to the mucous membrane of the mouth.

B.—*Branches of the second part.*—(*a*) The *deep temporal* branches, two in number (anterior and posterior), ascend between the temporal muscle and the cranium, supply that muscle, and anastomose with the middle temporal artery, and with minute branches of the lachrymal artery, through small foramina in the malar bone.

(*b*) The *pterygoid* branches, small, short offsets, irregular in number and origin, are distributed to the pterygoid muscles.

(*c*) The *masseteric* is a small but regular branch which passes from within outwards, with the nerve of the same name, through the sigmoid notch of the lower jaw, to the deep surface of the masseter muscle. It is often joined at its origin with the posterior temporal branch.

(*d*) The *buccal* branch runs obliquely downwards and forwards upon the buccinator muscle with the buccal nerve; it is distributed to the muscles and mucous membrane of the cheek, and anastomoses with the branches of the facial and other arteries of this region.

C.—*Branches of the third part.*—(*a*) The *posterior dental* or *alveolar* branch, arising near the back of the superior maxilla, frequently in common with the infraorbital branch, runs tortuously downwards upon the zygomatic surface of the bone, and gives off branches which enter the posterior dental canals, and supply the upper molar and bicuspid teeth, besides ramifying in the lining membrane of the maxillary sinus. Other small branches supply the gum.

(*b*) The [illegible] artery runs horizontally forwards into the infraorbital canal, and having traversed that canal along with the superior maxillary nerve, emerges upon the face at the infraorbital foramen.

While in the canal, it sends upwards into the orbit small branches which [illegible] and the inferior [illegible] muscles of the [illegible] branch sometimes [illegible] descends in the [illegible] of the same name to supply the front teeth and the [illegible] of the antrum. On the face it gives [illegible] to the lachrymal sac and inner angle of the orbit, anastomosing [illegible] and facial arteries, and sends [illegible] superioris, which [illegible] and facial arteries.

[illegible] descends through the [illegible] and runs along [illegible] the glands, and the [illegible] descends through the [illegible] artery. On its [illegible] smaller palatine als, which are distributed to the soft palate and tonsil, and comnicate with the ascending palatine branch of the facial artery.

d) The *Vidian* branch traverses the Vidian canal with the nerve of same name; it is distributed to the Eustachian tube and the top of pharynx, and sometimes sends a small vessel into the tympanum.

e) The *pterygo-palatine,* a very small branch, passes backwards ough the pterygo-palatine canal to reach the top of the pharynx, to ich, and to the Eustachian tube and sphenoidal sinus, it is distributed.

f) The *nasal* or *spheno-palatine* artery enters the spheno-palatine amen, and divides into branches, some of which ramify extensively r the spongy bones, while others supply the ethmoidal cells, the frontal us, and the antrum. One long branch, the *naso-palatine artery* or *tery of the septum,* runs downwards and forwards in the groove on s vomer, and ends in a small vessel which enters the incisor foramen communicate with the descending palatine artery.

**Varieties.**—The internal maxillary artery is very constant in its place of gin. It has, however, been seen to arise from the facial (R. Quain, Hyrtl); d in two cases, after leaving the temporal artery below the angle of the jaw, it rced the internal pterygoid muscle in its course upwards into the zygomatic ma (Joessel, W. Gruber).

The number of branches arising from the internal maxillary artery is frently reduced owing to two or more taking origin by a common trunk. The *iddle meningeal artery* occasionally furnishes the lachrymal (usually an offset f the ophthalmic), or even the ophthalmic artery itself; and on the other hand the phthalmic has been seen to give off the middle meningeal; peculiarities which ay be explained as resulting from the enlargement of an ordinary anastomosing anch. The *anterior deep temporal artery* may reinforce or replace the lachryal artery by a similar enlargement of an anastomosing branch. The *buccal, nterior dental* or *infraorbital artery* may be larger than usual, supplying a ficiency of the facial artery.

## INTERNAL CAROTID ARTERY (II).

COURSE AND RELATIONS.—The internal carotid artery is distributed o the brain, to the eye with its appendages, and in part to the forehead nd nose. It extends directly upwards from the termination of the ommon carotid artery, opposite the upper border of the thyroid cartige, to the carotid canal of the temporal bone. Traversing this canal, it nters the cranial cavity by the inner part of the foramen lacerum; t then passes forwards in the carotid groove on the side of the body f the sphenoid bone, at the fore part of which it makes a sharp bend ith its convexity directed forwards; and lastly, it turns upwards on he inner side of the anterior clinoid process to reach the inner end of he Sylvian fissure of the brain, where it terminates by dividing into the nterior and middle cerebral arteries.

*In the neck,* the internal carotid artery lies at first behind the external arotid, and is covered only by the sterno-mastoid muscle with the latysma myoides and fascia. It soon, however, passes beneath the igastric and stylo-hyoid muscles, gaining the inner side of the external arotid trunk, and is then deeply placed beneath the parotid gland, the tyloid process and the stylo-pharyngeus muscle. Behind the artery is the ectus anticus major muscle, and on its inner side are the pharynx and he tonsil. The *internal jugular vein* is in contact with the artery as far s the base of the skull, lying on its posterior and outer aspect, and the wo are enclosed, together with the pneumo-gastric nerve, in a pro-

longation of the carotid sheath. The vessel is crossed by th
*artery* beneath the digastric, and by the *posterior auricular ar*
that muscle. The *pneumo-gastric nerve* and the *upper cervica*
*of the sympathetic* are placed deeply behind the artery ; the *h*
*nerve* crosses it superficially near the lower border of the dig
higher up the *glosso-pharyngeal nerve* and the *pharyngeal br*
*pneumo-gastric* pass forwards between the external and interna
while the *superior* and *external laryngeal nerves* are intern
vessels. Close to the base of the skull the *glosso-pharyngea*
*gastric*, *spinal accessory* and *hypoglossal nerves* issue between
and its companion vein.

*In the carotid canal*, the artery first ascends for a short dista
placed immediately in front of the tympanum and internal
passes horizontally forwards and inwards to the foramen lacer
it turns upwards in the groove of the sphenoid internal to t
(p. 43). It is here accompanied by the *ascending branch* of
*cervical ganglion of the sympathetic.*

*Within the cranium*, the internal carotid artery lies along th
the cavernous sinus as it passes forwards in the groove on the
body of the sphenoid ; it is surrounded by filaments of the s
the *sixth nerve* is in contact with its outer side, and it receives, i
with these nerves, an investment from the thin lining membr
sinus. Perforating the upper wall of the sinus on the inner s
anterior clinoid process, the artery ascends between the *secon*
*nerves* to the anterior perforated spot at the base of the brair
divides into its two terminal branches.

BRANCHES.—In the neck the internal carotid artery gives
branch. While in the carotid canal it sends a small offi
tympanum, which anastomoses with the other tympani
Within the cavernous sinus some small branches proceed 1
supply the adjacent dura mater, the pituitary body and the
ganglion.

Opposite the anterior clinoid process, the internal carotid gi
ophthalmic artery ; and at the Sylvian fissure of the brain, befo
into the anterior and middle cerebral arteries, it gives off or is
the posterior communicating artery, a slender anastomotic br
unites the internal carotid with the posterior cerebral bran
basilar artery.

**Varieties.**—The cervical part of this artery is sometimes tortuou
very rare cases the internal carotid has arisen directly from the arch
or from the division of the innominate artery (p. 365). A few exa
entire absence are recorded. Its lower part occasionally gives or
occipital or the ascending pharyngeal artery ; and in one case its
portion furnished a considerable meningeal offset to the posterior f
skull (Curnow, Journ. Anat. viii., 155). A large communicating bran
seen passing from the part of the internal carotid within the cave
backwards to the trunk of the basilar artery (R. Quain, Duret, Tarcni

### BRANCHES OF THE INTERNAL CAROTID ARTERY.

**1. Ophthalmic artery** (**v**).—This artery, arising from th
carotid below the anterior clinoid process, enters the orbit by
foramen, below and to the outer side of the optic nerve. It so
its direction, passing over, seldom under, the nerve to reach
wall of the orbit, along which it runs forwards between th

que and internal rectus muscles, and ends opposite the internal angular ess of the frontal bone by dividing into the nasal and frontal ries.

ranches.—(a) The *lachrymal artery*, arising on the outer side of the ic nerve, passes forwards along the upper border of the external rectus scle to the lachrymal gland, in which the greater number of its nches are distributed. Some of the branches pass onwards to the lids and conjunctiva, joining with other palpebral branches; and one two delicate *malar* branches pierce the malar bone and reach the mporal fossa, where they join branches from the deep temporal arteries. e lachrymal artery has also branches of communication through the henoidal fissure with small offsets from the middle meningeal artery.

(b) The *central artery of the retina*, a small vessel, pierces the sheath d substance of the optic nerve about a quarter of an inch behind its nction with the eyeball, and runs imbedded within it to the retina, in hich it ramifies. (See description of the eye in Vol. II.)

(c) The *supraorbital* branch, arising as the artery crosses the optic rve, ascends above the muscles, courses forwards to the supraorbital otch, in company with the frontal nerve, and terminates on the forehead. t distributes branches to the eyelids, and communicates with the supercial temporal and frontal arteries.

(d) The *ciliary arteries* are divided into two sets, posterior and anterior. he *posterior* are four or five small vessels which divide into numerous ranches (fifteen to twenty) as they pass forwards, surrounding the optic erve, to reach the back of the eyeball. Piercing the sclerotic coat near e entrance of the optic nerve, the greater number (*short ciliary arteries*) ass at once into the choroid coat; but two, which are somewhat larger han the others, extend forwards, one on each side of the eye, between e sclerotic and choroid coats to the ciliary muscle and iris, and are istinguished as the *long ciliary arteries.* The *anterior ciliary arteries*, x to eight, are derived from the muscular and lachrymal branches; ey form a vascular ring beneath the conjunctiva at the fore part of e eyeball, and then pierce the sclerotic within a line or two of the argin of the cornea. The mode of distribution of these arteries within e eyeball is described in the account of the anatomy of the eye in Vol. II.

(e) Small *muscular* offsets arise at uncertain intervals from the trunk f the artery, as well as from the lachrymal and supraorbital branches; n addition to these there are two more regular branches, a *superior*, hich is distributed to the upper and inner muscles of the orbit, and an *ferior*, larger and more constant, to the lower and outer muscles.

(f) The *ethmoidal arteries* are two in number, a posterior and an terior. The *posterior* enters the posterior internal orbital canal and is stributed to the mucous membrane of the posterior ethmoidal cells and pper part of the nose. The *anterior* is larger and passes with the nasal rve into the cranial cavity where it gives off small *anterior meningeal* anches to the dura mater in the anterior fossa, and then descends into e nose (*anterior nasal artery*). It supplies the mucous membrane of e fore part of the nasal fossa, frontal sinus and anterior ethmoidal cells, d one small twig accompanies the termination of the nasal nerve to the n of the nose.

(g) The two *palpebral* branches, *superior* and *inferior*, arise near the nt of the orbit, usually together, but soon diverge, one lying above, the er below the internal tarsal ligament. They send small branches to internal carotid at the inner end of the fissure of Sylvius, runs forwards and inwards to reach the fore part of the longitudinal fissure between the cerebral hemispheres; and as it enters this fissure it is connected with the vessel of the opposite side by the *anterior communicating artery*, a small transverse branch not more than two lines in length. The two anterior cerebral arteries, lying close together, in the next place turn round the anterior border of the corpus callosum, gain its upper surface, and break up into their terminal branches, which are distributed mainly to the frontal lobe of the hemisphere. A few small twigs enter the anterior perforated spot, and others supply the optic nerve.

The *middle cerebral artery* (iii) passes obliquely outwards and upwards in the fissure of Sylvius to the surface of the island of Reil, where it divides into several branches, which ramify in the pia mater investing the outer surface of the hemisphere. Numerous small branches, springing from the artery close to its origin, turn upwards at once, and enter the brain at the anterior perforated spot.

One or two *anterior choroid arteries*, which sometimes arise directly from the internal carotid, pass backwards and enter the fissure between the temporo-sphenoidal lobe and the crus cerebri, to reach the descending cornu of the lateral ventricle, in which they are distributed to the choroid plexus.

**Varieties.**—In rare instances, the anterior cerebral arteries are united into a single trunk, like the basilar artery behind, and this again divides into a right and left artery. Both anterior cerebral arteries have also been seen to spring from one internal carotid, by means of a common trunk which bifurcated as it entered the longitudinal fissure. The anterior communicating artery is sometimes double.

The posterior communicating artery is sometimes connected with the middle cerebral artery instead of the trunk of the internal carotid. The posterior cerebral artery of one side frequently arises by an enlarged posterior communicating artery from the internal carotid, and is connected only by a slender vessel with the basilar. The opposite condition, in which the middle cerebral artery is derived from the posterior, has been recorded by Hyrtl.

**Circle of Willis.**—A remarkable anastomosis exists between the branches of the vertebral and internal carotid arteries within the cranium, by which the circulation is equalised in different parts of the brain, and any irregularity which might arise from the obliteration of one, or even two of the vessels, may speedily be remedied by a corresponding enlargement of the others. This anastomosis, known as the *circle of Willis*, is formed in the following manner. The anterior cerebral arteries are connected together, as already mentioned, by the anterior communicating artery. The right and left internal carotids, the trunks from which the anterior cerebral arteries arise, are united by the posterior communicating arteries to the posterior cerebral arteries, and these arise behind from a single trunk—the basilar artery. Within or opposite to the area of this vascular circle are the following parts of the encephalon, viz., the lamina cinerea, optic commissure, infundibulum and tuber cinereum, corpora albicantia, and posterior perforated spot.

**Distribution of the cerebral arteries.**—The mode of distribution of the arteries of the cerebrum has been studied by Heubner and Duret. According to these authors, the three cerebral arteries—anterior, middle, and posterior—give origin to two very distinct systems of vessels. The first of these, consisting of branches given off by the arteries while within or immediately after leaving the le of Willis, is destined to the great central ganglia, and is called the *central* onjunctiva, the caruncle and the lachrymal sac, and then pass out- s between the orbicularis muscle and the tarsus, to form arches, one the free margin of each lid, with the palpebral branches of the ymal artery.

) The *nasal* branch courses forwards above the internal tarsal liga- to the root of the nose, where it ramifies, maintaining a free com- ication with the nasal and angular branches of the facial artery.

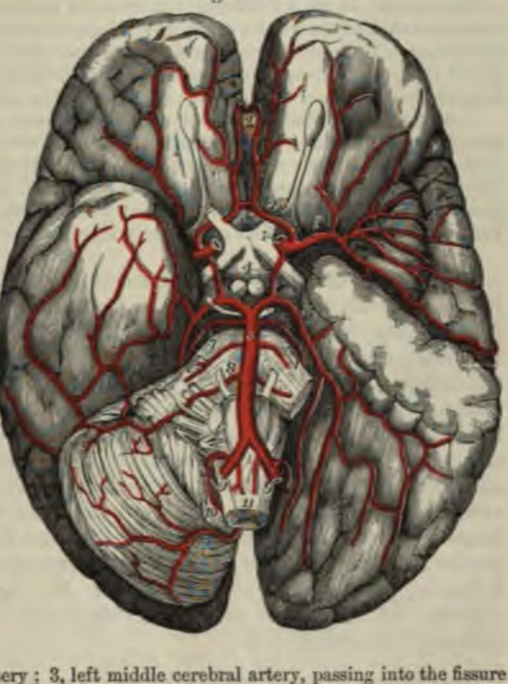
) The *frontal artery* turns upwards round the inner end of the tal arch, and is distributed to the integument, muscles and periosteum he mesial part of the forehead, anastomosing with the supraorbital ry and with the corresponding artery of the other side.

arieties.—The lachrymal artery occasionally, and in rarer cases a large part ven the whole of the ophthalmic itself, arises from the middle meningeal ry; or the ophthalmic artery has been seen to give off the middle meningeal 381). The nasal branch is sometimes large, and supplies a deficiency of the ial artery.

**2** and **3. Cerebral arteries.**—The terminal branches of the internal rotid artery supply the anterior two-thirds of the cerebrum.

The *anterior cerebral artery* (iv), commencing at the division of the

Fig. 240.



240.—THE DISTRIBUTION OF THE INTERNAL CAROTID AND VERTEBRAL ARTERIES AT THE BASE OF THE BRAIN (altered from Hirschfeld and Leveillé). (A. T.) ½

On the left side a por- of the temporo-sphe- dal lobe of the cerebrum been removed, so as to n up the fissure of vius and expose the nd of Reil; and the half of the cerebellum been removed to show lower surface of the terior part of the cere- l hemisphere: 1, placed the optic commissure, nts to the divided stem the left internal carotid ery; 2, left anterior ebral artery, exposed y by the removal of optic nerve; 2′, placed the genu of the corpus osum between the two erior cerebral arteries; placed on the lamina erea in front of the ic commissure, marks anterior communicating artery; 3, left middle cerebral artery, passing into the fissure Sylvius and distributing its branches over the convolutions of the island of Reil and ers beyond; 4, placed between the infundibulum and the corpora albicantia, points by ine to the left posterior communicating artery; 5, basilar artery; 6, left posterior ebral artery; 7, placed on the pons Varolii, points to the right superior cerebellar ry; 8, anterior cerebellar artery; between 7, and 8, one of the largest of the sverse branches of the basilar artery; 9, 9, right and left vertebral arteries; 10, rior cerebellar artery; 11, anterior spinal arteries.

internal carotid at the inner end of the fissure of Sylvius, runs forwards and inwards to reach the fore part of the longitudinal fissure between the cerebral hemispheres; and as it enters this fissure it is connected with the vessel of the opposite side by the *anterior communicating artery*, a small transverse branch not more than two lines in length. The two anterior cerebral arteries, lying close together, in the next place turn round the anterior border of the corpus callosum, gain its upper surface, and break up into their terminal branches, which are distributed mainly to the frontal lobe of the hemisphere. A few small twigs enter the anterior perforated spot, and others supply the optic nerve.

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*Relation to nerves.*—The *pneumo-gastric nerve* is in front of and parallel to the first part of the left subclavian artery, but in contact with it only at its lower part. The *phrenic nerve* descends over the artery along the inner margin of the scalenus muscle, immediately outside the

Fig. 241.

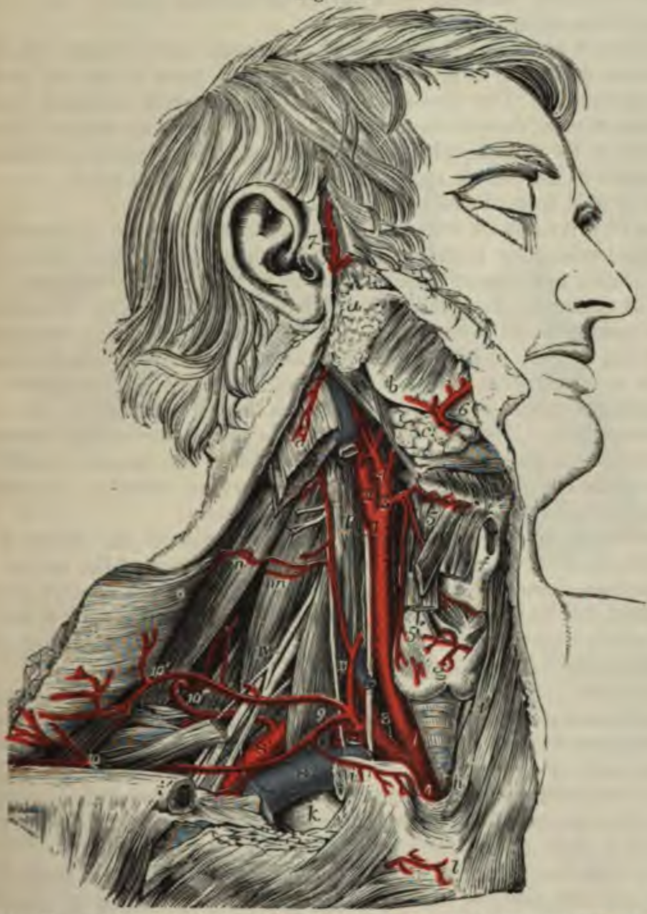


Fig. 241.—View of the right common carotid and subclavian arteries, with the origin of their branches and their relations. (R. Quain.) ⅓

For the explanation of the references in the upper part of this figure, see p. 361. The following explanation relates to the subclavian artery and its branches: 8, first part, 8′, third part of the subclavian artery; 8″, subclavian vein, shown by the removal of a portion of the clavicle; 9, is placed on the scalenus anticus, in the angle between the superficial cervical and suprascapular branches of the thyroid axis; 10, outer part of the suprascapular artery; 10′, superficial cervical artery, passing into the deep surface of the trapezius; 10″, posterior scapular artery, rising from the third part of the subclavian artery, and passing through the brachial plexus of nerves and under the levator anguli scapulæ; 11, on the scalenus anticus, points to the inferior thyroid artery, near the place where the ascending cervical artery is given off; the phrenic nerve lies on the muscle to its outer side; *i*, the suprasternal twig of the suprascapular artery.

thyroid axis. The *cardiac nerves* of the left side, descending from the neck, are close to the artery, and the cord of the *sympathetic* is behind.

THE SECOND PART OF THE SUBCLAVIAN ARTERY, the short portion concealed by the anterior scalenus muscle, forms the highest part of the arch described by the vessel across the root of the neck. Somewhat less deeply placed than the first part, it is covered by the sterno-mastoid and anterior scalenus muscles, with layers of cervical fascia. Behind and below, it lies on the pleura.

*Relation to veins and nerves.*—The *subclavian vein* is farther forwards and lower than the artery, and is separated from it by the anterior scalenus muscle. The *phrenic nerve*, which descends obliquely inwards over that muscle, crosses the first part of the subclavian artery of the left side close to the muscle, while on the right side, not having quite reached the margin of the muscle at the level of the artery, it is usually separated by the muscle from the second part of the artery.

THE THIRD PART OF THE SUBCLAVIAN ARTERY lies for its greater part in a small triangular space, the sides of which are formed by the omohyoid muscle and clavicle, and the base by the anterior scalenus. The artery is nearer to the surface here than elsewhere, being covered only by the platysma and layers of cervical fascia, but towards its termination it becomes deeper, sinking under the clavicle and the subclavius muscle. It rests upon the first rib; and behind it is the scalenus medius.

*Relation to veins.*—The *subclavian vein* is still anterior to, and lower than, the artery. The *external jugular vein* crosses in front of the artery, and receives on the outer side from the shoulder the two veins which accompany the suprascapular and transverse cervical arteries. These veins in some cases form a sort of plexus over the artery.

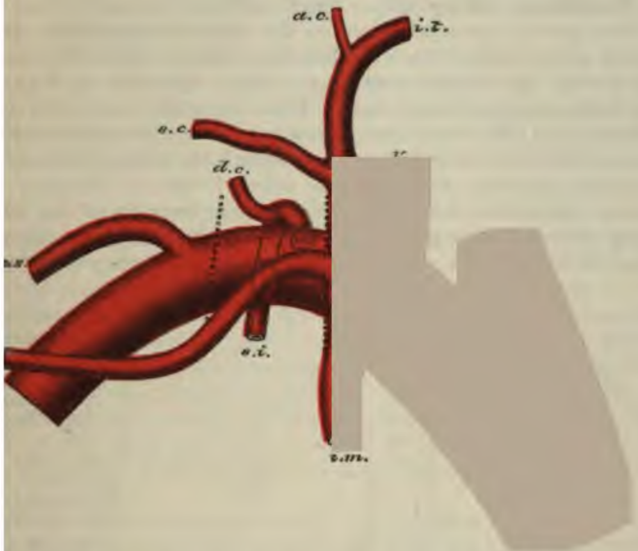
*Relation to nerves.*—Above the vessel are placed the *nerves of the brachial plexus*, the lowest trunk, formed by the union of the last cervical and the first dorsal nerves, being behind and in close contact with it. The small *nerve to the subclavius* passes down over the artery, and the space which lodges the artery is crossed in front by the *descending superficial branches* from the *cervical plexus* of nerves.

BRANCHES.—Four branches are commonly described as arising from each subclavian artery. Of these, three, namely, the vertebral, the internal mammary, and the thyroid axis, usually spring close together from the first part of the artery, near the inner side of the anterior scalenus muscle; while the fourth branch, the superior intercostal, is generally found also internal to that muscle on the left side, but arising under cover of it, from the second part of the artery, on the right.

The vertebral artery springs from the upper and back part of the subclavian, and ascends in the neck to reach the interior of the skull; the internal mammary proceeds from the lower side of the vessel, and descends into the fore part of the chest and abdomen; the thyroid axis arises from the front of the artery, and divides into three branches, one of which, the inferior thyroid, is distributed in the fore part of the neck, while the other two, the suprascapular and the transverse cervical, pass outwards across the neck to the shoulder; lastly, the superior intercostal and deep cervical arise by a common stem from the back part of the artery, and pass into the upper part of the thoracic wall and the posterior muscles of the neck. The deep cervical is reckoned by some writers as a fifth branch of the subclavian artery, but it usually rises in common with the superior intercostal artery.

er branch, in the majority of instances, arises from the second part of the artery. This is generally the posterior scapular branch which otherwise is derived from the transverse cervical, e divisions of the thyroid axis.

Fig. 242.



—Origin of the branches of the right subclavian artery (modified from Wyeth). (G. D. T.) Natural size.

ral artery ; *i.t*, inferior thyroid artery, giving off *a.c*, the ascending cervical ; cial cervical artery ; *ss*, suprascapular artery ; the last three arising together roid axis ; *i.m*, internal mammary artery ; *s.i*, superior intercostal artery, from es *d.c*, the deep cervical ; *p.s*, posterior scapular artery. The thick dotted te the position of the inner and outer borders of the anterior scalenus muscle.

**es.**—The variations in *origin* of the subclavian arteries have been l along with the peculiarities of the arch of the aorta.

nd *connections.*—The height to which these vessels reach in the neck to some variation. Most commonly the second part of the artery is m half to three-quarters of an inch above the clavicle (the shoulder ressed to the full extent), but it is sometimes, especially on the right d as high as an inch, or even an inch and a half above the level of the on the other hand it may be entirely under cover of the clavicle. The of the artery is not unfrequently concealed by the posterior belly of yoid, when that muscle has an attachment to the clavicle (p. 292) or is vn to the bone by the fascia. More rarely the artery is covered by an wide clavicular attachment of the trapezius (p. 191). Occasionally the artery perforates the anterior scalenus muscle, and in rarer cases it has d altogether in front of the muscle, and close to the subclavian vein. has also been seen to pass with the artery behind the scalenus muscle ; r three cases are recorded in which the positions of the artery and vein sed.

*es.*—The places of origin of the several branches of the subclavian subject to frequent slight variations, and it occasionally happens that

one or more of the first three branches are moved considerably inward
their usual position, or outwards to another division of the subclavian.
times two, and much more rarely three, branches arise from the third part
vessel. A small muscular and spinal branch is frequently given off fr
second part of the artery.

### BRANCHES OF THE SUBCLAVIAN ARTERY.

**1. Vertebral artery (iii).**—The vertebral artery arises from the
and back part of the subclavian, on the right side generally about
quarters of an inch from its commencement, on the left side fr
bend formed by the main trunk as it turns outwards at the root
neck, and, passing upwards and a little backwards and outwards,
the foramen in the transverse process of the sixth cervical verteb
then ascends in a vertical direction through the series of foramina
transverse processes, as far as the upper border of the axis, w
inclines outwards to reach the corresponding foramen of the atlas
passing through that aperture it winds backwards and inwards
groove on the neural arch of the atlas, and, piercing the dura

Fig. 243.

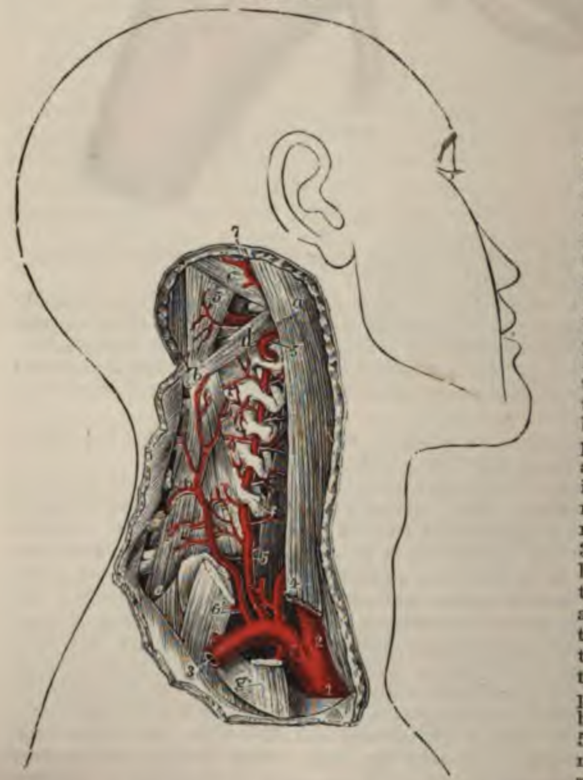


Fig. 243.—Di
SECTION OF T
SHOWING TH
AND COURSE
VERTEBRAL
(from Tieden

*a*, Upper pa
sterno-mastoid
its clavicular p
vided below;
process of axi
perior oblique
*d*, on the inferi
muscle, points
to the posteri
the atlas; *e*, se
colli; *f*, place
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the deep cervical artery, arising in common with 6′, the superior intercostal; 7,
artery, emerging from beneath the sterno-mastoid.

enters the skull through the foramen magnum. Finally, it proceeds upwards and forwards, turning round from the side to the front of the medulla oblongata, and unites with the vessel of the opposite side, at the lower border of the pons Varolii, to form the *basilar artery*.

At its commencement, the vertebral artery lies behind the internal jugular, as well as its own companion vein, and on approaching the vertebræ it passes between the longus colli and the scalenus anticus muscles. On the left side, the thoracic duct crosses in front of the artery from within outwards.

While within the foramina of the cervical vertebræ, the artery is accompanied by a plexus of the sympathetic nerve and by the vertebral vein: the cervical nerves as they emerge from the intervertebral foramina pass behind it. The suboccipital nerve lies beneath it in the groove of the atlas, and at that point the artery is covered by the superior oblique muscle.

Within the skull it turns round the side of the medulla oblongata, between the origin of the hypoglossal and the anterior root of the suboccipital nerves, and it then lies between the anterior surface of the medulla oblongata and the basilar process of the occipital bone.

*Branches.*—A. *In the neck.*—(*a*) *Spinal* branches. These are several small offsets which pass through the intervertebral foramina into the spinal canal, and there divide, each into two branches; one of these passes along the roots of the spinal nerves, supplying the spinal cord and its membranes, and anastomoses with the other spinal arteries; the other branch ramifies on the back part of the bodies of the vertebræ in the same manner as similar branches derived from the intercostal and lumbar arteries (see p. 447).

(*b*) *Muscular* branches of variable size are distributed to the deep-seated cervical muscles, and anastomose with the ascending cervical, deep cervical and occipital arteries.

B. *Within the cranium.*—(*a*) The *posterior meningeal artery*, sometimes double, is a small branch which arises opposite the foramen magnum, and ramifies beneath the dura mater in the lower occipital fossa, and in the falx cerebelli.

(*b*) The *posterior spinal artery* inclines downwards on the medulla oblongata to reach the back part of the spinal cord; aided by reinforcements from small arteries which ascend upon the nerves through the intervertebral foramina, it may be traced as a minute tortuous vessel, or rather a series of little inosculating vessels, lying behind the roots of the nerves, as far as the lower end of the cord, where it communicates with the lower part of the anterior spinal artery.

(*c*) The *anterior spinal artery*, somewhat larger than the preceding, arises near the end of the vertebral artery, and descends obliquely on the front of the medulla oblongata. Near the foramen magnum, it unites with the corresponding vessel of the opposite side, so as to form a single trunk, which descends along the middle line in front of the spinal cord, forming the upper part or commencement of the anterior median artery of the cord. This anterior spinal branch of the vertebral artery supplies only the upper part of the cord; the remainder being provided with a series of small arteries, which are derived in the neck from the vertebral and ascending cervical arteries, in the back from the intercostals, and below this from the lumbar, ilio-lumbar, and lateral sacral arteries. These small vessels enter the spinal canal at irregular intervals through the intervertebral foramina, and, passing along the anterior roots of the nerves, communicate with each other along the middle line by means of ascending and descending branches; so that, by a succession of anastomoses, a slender single vessel extends from the one end to the other of the cord. This vessel, or chain of inosculating vessels, supplies the pia mater and the substance of the cord—some branches entering the anterior median fissure. At the lower end of the spinal cord it ends as a slender branch continued downwards on the filum terminale.

On a part of the spinal cord near the lower end, and in front of the posterior roots of the nerves, may be found another small artery, also derived from the branches ascending on the posterior roots of the nerves.

(*d*) The (*posterior*) *inferior cerebellar artery* (vi), the largest of the branches, arises from the vertebral near the pons, and sometimes from the basilar artery: it turns backwards and outwards over the restiform body and near the lower lateral margin of the fourth ventricle, to enter the fore part of the vallecula, where it divides into two branches. One of these runs backwards in the sulcus between the cerebellar hemisphere and the inferior vermiform process, its offsets being distributed mainly to the latter structure, and anastomosing with those of the opposite artery; while the other inclines outwards and ramifies on the under surface of the hemisphere as far as its outer border, over which the ultimate divisions of both branches anastomose with those of the superior cerebellar artery. Before dividing, this artery gives branches to the choroid plexus of the fourth ventricle.

**Varieties.**—*Origin.*—While the vertebral artery arises, in the great majority of cases, on the right side from the subclavian between half an inch and an inch from its beginning, and on the left side from the same trunk as it bends outwards, its range of origin extends over the whole of the first part of the subclavian artery. In those cases in which the right subclavian artery is given off independently from the posterior part of the arch of the aorta, the right vertebral artery sometimes arises from the common carotid of the same side. In some rare instances the right vertebral artery has been seen arising from the aorta, between the right subclavian and carotid (p. 358), between the innominate and left carotid (Meckel), or beyond the left subclavian artery and passing to its usual place behind the œsophagus (Hyrtl, Struthers).

The left vertebral artery is not unfrequently derived from the aorta, in which case it generally arises between the left carotid and subclavian arteries, but sometimes it is the last of the branches from the arch.

Either vertebral artery may as a very rare occurrence arise by two roots, both proceeding from the subclavian artery, or one from the subclavian and one from the aorta or from the inferior thyroid artery. One example of three roots to a vertebral artery (right) is recorded (R. Quain, pl. 24, fig. 2).

*Course.*—The vertebral artery not unfrequently enters the foramen of the fifth or fourth cervical vertebra; more rarely the third, or even the second. On the other hand, it has been seen to enter the foramen of the seventh vertebra.

*Size.*—One vertebral artery, more frequently the left, is sometimes much larger than the other.

*Branches.*—The vertebral artery has been found, though very rarely, to give off the inferior thyroid or superior intercostal artery. The inferior cerebellar artery is often wanting on one side.

The **basilar artery** (iii), the single trunk formed by the junction of the right and left vertebral arteries, extends from the lower to the upper border of the pons Varolii, along the median groove of which it lies under cover of the arachnoid. The length of this artery is therefore ut equal to the depth of the pons, at the upper border of which it s by dividing into the two posterior cerebral arteries.

*Branches.*—Besides numerous small branches to the substance of the s, the basilar artery gives off the following :—

a) The *transverse arteries*, several on each side, pass directly outwards. , the *auditory artery*, accompanies the nerve of the same name into the rnal auditory meatus and supplies the labyrinth of the ear.

b) The *anterior* (*inferior*) *cerebellar arteries* (vi) pass backwards, one each side, to the anterior part of the under surface of the cerebellum, stomosing with the inferior cerebellar branches of the vertebral ries.

c) The *superior cerebellar arteries* (v) arise so close to the bifurcation he basilar, that this artery is often described as dividing into four nches. Each one passes outwards immediately below the third nerve, , entering the groove between the pons Varolii and the crus cerebri, s backwards round the latter, close to the fourth nerve, to reach upper surface of the cerebellum, where it divides into branches. Of e some extend outwards, and one or more backwards along the erior vermiform process, to reach the circumference of the cerebellum, re they anastomose with the branches of the inferior cerebellar ry; while others run inwards to supply the vermiform process and valve of Vieussens, and in part the velum interpositum.

he **posterior cerebral artery** (iv), passes outwards, on each side, allel to the superior cerebellar artery, and separated from it at its gin by the third nerve, which comes forwards between the two vessels. urns backwards round the crus cerebri, and then runs outwards and wards on the under surface of the posterior part of the cerebrum, sing near the hinder extremity of the corpus callosum. Close to its gin it gives off several small branches to the posterior perforated spot, as it turns backwards it is joined by the *posterior communicating ry*, thus taking part (as described at p. 386) in the formation of the le of Willis. It then gives off one or two *posterior choroid arteries* the velum interpositum and choroid plexuses, and its terminal nches supply the occipital lobe and the lower and inner parts of the poro-sphenoidal lobe of the cerebrum (see p. 387).

**arieties.**—The basilar artery is originally formed by the coalescence of two arate vertebral arteries, and traces of a septum are sometimes found in its erior (Davy, "Researches," &c., vol. i, p. 301). The occurrence of a perforan of the vessel, which is occasionally seen, may be likewise attributed to the omplete fusion of the two arteries.

he posterior cerebral artery is occasionally given off on one side from the ernal carotid, by an enlargement of the posterior communicating branch.

2. **Thyroid axis** (ii).—The thyroid axis springs from the fore part the subclavian artery, close to the inner side of the anterior scalenus scle. It is a short thick trunk, and receives the name of "axis," ause, two or three lines from its origin, it divides into branches, ich diverge in different directions : these are—the inferior or ascend- thyroid, the suprascapular, and a third branch, which is either the nsverse cervical, or one of the branches into which that artery, when sent, divides, viz., the superficial cervical.

**arieties.**—The thyroid axis has been seen arising beyond the scalenus anti- muscle. It may be associated at its origin with another branch ; most frequently with the internal mammary; rarely with the vertebral, superior intercostal, or deep cervical artery. In some cases the axis is absent, the three branches arising separately from the subclavian.

A. The **inferior thyroid artery** (iv) (fig. 246, p. 405), passes directly upwards in front of the vertebral artery, and after a short course bends inwards and downwards behind the sheath of the large cervical vessels, and also behind the sympathetic nerve, the middle cervical ganglion of which, when present, often rests upon this vessel. The artery then makes another curve in the opposite direction, and is distributed to the lower part of the thyroid body. Its branches communicate freely with those of the superior thyroid artery, and with the corresponding artery of the other side.

*Branches.*—(*a*) *Muscular* branches to the scalenus anticus, longus colli, inferior constrictor of the pharynx, and the infrahyoid muscles.

(*b*) The *ascending cervical* branch (v) arises at the point where the inferior thyroid turns inwards behind the carotid artery; it proceeds upwards, close to the phrenic nerve, in the groove between the scalenus anticus and rectus anticus major, giving *muscular* branches to both, and a few which pass transversely outwards across the neck. These branches communicate with others sent outwards from the vertebral artery. To the spinal canal the ascending cervical artery sends two or three *spinal* branches, which enter the intervertebral foramina along the cervical nerves, and assist in supplying the bodies of the vertebræ, and the spinal cord and its membranes.

(*c*) An *inferior laryngeal* branch of irregular size ascends with the recurrent nerve to the back of the larynx, and is distributed to the muscles and mucous membrane in that situation.

(*d*) *Tracheal* branches ramify over the trachea, and anastomose below with the bronchial arteries.

(*e*) One or more *œsophageal* branches descend upon the œsophagus into the chest, and anastomose with the œsophageal branches of the aorta.

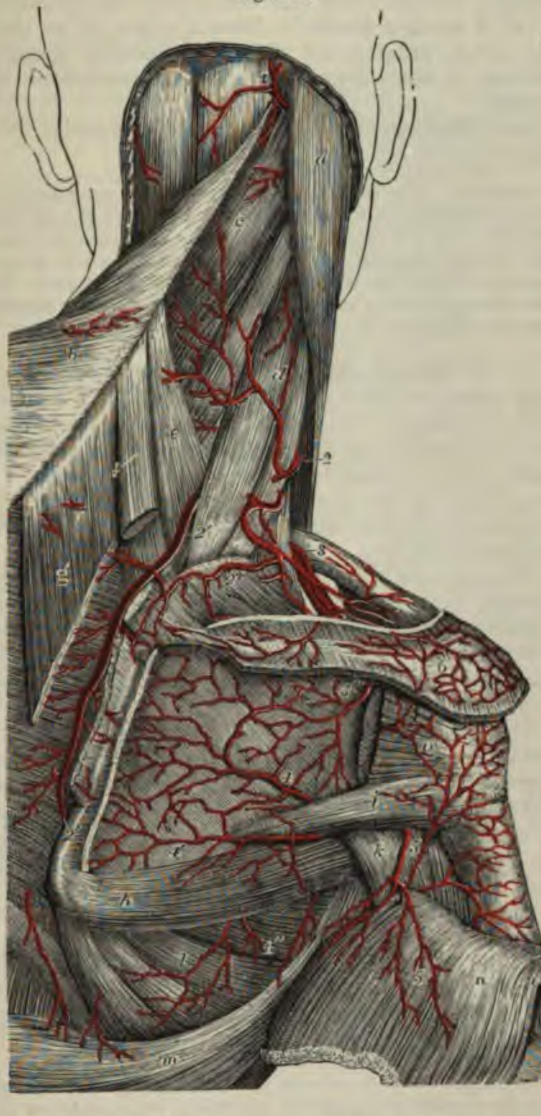
**Varieties.**—The inferior thyroid artery occasionally arises as an independent branch from the subclavian; rarely from the common carotid or the vertebral. Instances have occurred—very rarely, however—of the presence of two inferior thyroid arteries, one passing over the common carotid artery. The inferior thyroid artery varies much in size, and occasionally is altogether wanting. The several thyroid arteries are developed in inverse proportion to one another, diminution or absence of one being compensated for by an increased size of the others, or by an accessory artery, the *thyroidea ima* (p. 360).

The *ascending cervical artery* is occasionally derived from the subclavian or from one of the other branches of that vessel, as from the transverse cervical or the suprascapular. It is sometimes much larger than usual, and takes the place of the occipital artery. A branch from it not unfrequently compensates for the small size of the deep cervical artery.

B. The **suprascapular artery** (iv) (transverse scapular, or transverse humeral) arises from the thyroid axis, and courses from within outwards, being deeply placed at the root of the neck. At first it descends obliquely towards the clavicle, resting upon the scalenus anticus, and covered by the sterno-mastoid muscle; it then crosses the subclavian artery, and runs transversely outwards behind and parallel with the clavicle to the upper border of the scapula, where it is joined by the suprascapular nerve. Here the nerve passes through the suprascapular notch and beneath the ligament of the same name, but the artery usually crosses over that band, and inclining downwards enters the supraspinous fossa. It gives off

which ramify beneath the supraspinatus muscle, and is then
d down behind the neck of the scapula into the infraspinous
ere it terminates by anastomosing with the dorsal and posterior
arteries.

Fig. 244.



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tery; 4′,
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capular; 4″, thoracic branches of the subscapular artery; 5, posterior circum-
emerging from the quadrangular space, and sending branches upwards to the
int, forwards round the humerus, and downwards into the deltoid muscle; 6,
of the acromial branches of the suprascapular and acromio-thoracic arteries.

*Branches.*—(*a*) *Muscular* branches to the sterno-mastoid, subclavius, and other neighbouring muscles.

(*b*) A *suprasternal* twig crosses the inner end of the clavicle and is distributed to the skin at the upper and mesial part of the chest.

(*c*) The *supraacromial* branch passes outwards through the attachment of the trapezius to reach the surface of the acromion, on which it ramifies, anastomosing with offsets from the acromio-thoracic artery.

(*d*) A small *subscapular* branch, given off as the artery passes over the notch, anastomoses with the posterior scapular and subscapular arteries in the subscapular fossa and substance of the subscapularis muscle.

(*e*) Branches enter the dorsal scapular muscles, the bone and shoulder-joint.

**Varieties.**—The suprascapular artery has in some cases been observed to spring independently from the second or third part of the subclavian, or to arise from that vessel by a common trunk with the transverse cervical, or more rarely with the internal mammary. It has also been found to proceed from the axillary artery, and from the subscapular branch of that vessel. This artery is sometimes very small, in which case the deficiency is generally supplied by a branch of the posterior scapular.

C. The **transverse cervical artery**, the third branch of the thyroid axis, passes outwards a short distance above the clavicle, and therefore higher than the suprascapular artery. It crosses over the scaleni muscles and the brachial plexus, sometimes passing between the nerves of the latter, and is crossed by the omo-hyoid muscle. Beneath the upper margin of the trapezius, and near the outer edge of the levator anguli scapulæ, it divides into two branches, the superficial cervical and the posterior scapular.

The *superficial cervical artery* (v), ascends beneath the trapezius, and distributes branches to that muscle, the levator anguli scapulæ, and splenius muscles, as well as to the cervical glands and the integument. When the posterior scapular arises separately from the subclavian, the name superficial cervical may be given to the remaining part of the transverse cervical artery.

The *posterior scapular artery* (iv), whether arising from the transverse cervical artery or directly from the subclavian, passes backwards to the upper angle of the scapula, under cover of the levator anguli scapulæ, and then, changing its direction, runs downwards beneath the rhomboid muscles, as far as the inferior angle of that bone. It anastomoses freely on both surfaces of the scapula with the divisions of the suprascapular and subscapular arteries; and supplies branches to the rhomboids, serratus magnus, and latissimus dorsi muscles, communicating at the same time with the posterior branches of some of the intercostal arteries. Near the upper angle of the scapula this artery gives off a considerable *supraspinous* branch, which ramifies on the surface of the supraspinatus and supplies that muscle together with the overlying portion of the trapezius and skin.

**Varieties.**—The transverse cervical branch of the thyroid axis not unfrequently consists solely of the superficial cervical artery; and it often happens that the vessel derived from the thyroid axis is very small, and represents only in part the superficial cervical artery, a large vessel being given off from the second or third part of the subclavian and dividing near the levator anguli scapulæ into two branches, of which one ascends and represents the larger porion of the superficial cervical artery, while the other forms the posterior capular.

The transverse cervical artery is sometimes derived directly from the subclavian, eneath or even beyond the scalenus anticus muscle. The transverse or superficial cervical sometimes gives off the ascending cervical artery.

When the *superficial cervical* is separated from the posterior scapular, it sometimes arises from other sources than the thyroid axis, as from the suprascapular or the subclavian artery.

Fig. 245.

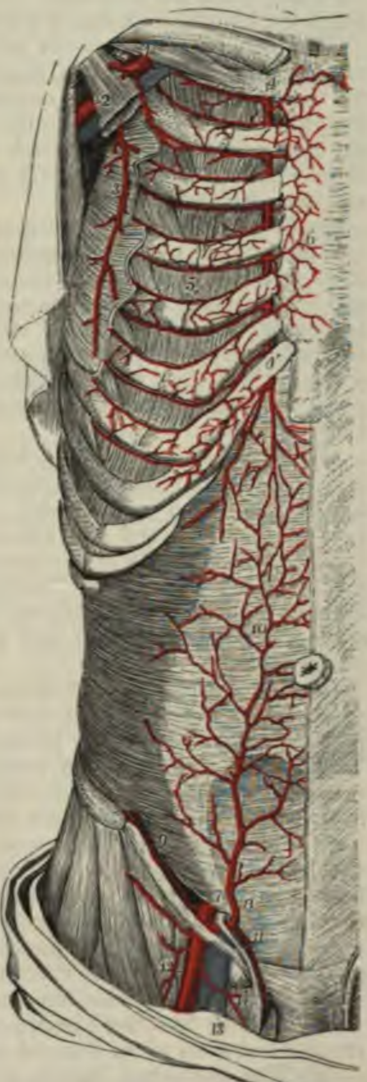


Fig. 245.—DISSECTION OF THE ANTERIOR THORACIC AND ABDOMINAL WALL, TO SHOW THE ANASTOMOSES OF THE INTERNAL MAMMARY, INTERCOSTAL, AND EPIGASTRIC ARTERIES (slightly altered from Tiedemann). (A.T.) ¼

The fore part of the serratus magnus, the external and internal oblique, and the rectus abdominis muscles have been removed; 1, upon the subclavius muscle, points to the first part of the axillary artery, giving rise to the acromio-thoracic artery, which is cut short; 2, upon the pectoralis minor, points to the lower part of the axillary artery and vein; 3, long thoracic artery; 4, on the cartilage of the first rib, the upper part of the internal mammary artery; 4′, the lower part of the same artery, giving its abdominal branch behind the cartilage of the seventh rib; 5, in the fourth intercostal space, the anastomosis of the internal mammary and intercostal arteries; 6, perforating branches of the internal mammary artery sending offsets over the front of the sternum; 7, on the transversalis muscle immediately above the internal abdominal ring, points to the last part of the external iliac artery, from which are seen rising, 8, the deep epigastric artery, and 9, the deep circumflex iliac; 10, the anastomosis of the epigastric with the abdominal branch of the internal mammary artery; 11, spermatic cord and cremasteric twig of the epigastric artery; 12, femoral artery; 13, femoral vein; 14, a lymphatic gland closing the crural ring.

**3. Internal mammary artery** (**iv**).—The internal mammary artery, remarkable for its length and the number of its branches, arises from the lower and fore part of the subclavian, opposite the thyroid axis. It runs at first forwards and downwards, as well as slightly inwards, to the hinder surface of the cartilage of the first rib, lying between this and the sac of the pleura; from this point it descends vertically behind the costal cartilages, about half an inch from the border of the sternum, as far as to the interval between the sixth and seventh cartilages, where it ends by dividing into two branches, which are known as the musculo-phrenic and superior epigastric arteries. The internal mammary artery is covered at its origin by the subclavian vein; and as it passes forwards it arches round the upper end of the innominate vein, and is crossed from without inwards by the phrenic nerve. In the chest it has the costal cartilages and the internal intercostal muscles in front, and lies at first upon the pleura; but lower down it is separated from the pleura by the triangularis sterni muscle. This artery has two companion veins, which are united into a single trunk at the upper part of the chest.

*Branches.*—(*a*) The *superior phrenic artery* or *comes nervi phrenici*, a very slender but long branch, arises from the artery at the upper part of the thorax, and descends, in company with the phrenic nerve, between the pleura and pericardium, to the diaphragm. It gives small offsets to the pericardium, and its terminal branches supply the fore part of the diaphragm and anastomose with the inferior phrenic (from the aorta) and musculo-phrenic arteries.

(*b*) The *mediastinal* branches, of very small size, ramify in the loose connective tissue of the mediastinal space, and supply the thymus body or its remains. *Pericardial* branches are given off to the pericardium; and branches named *sternal* are supplied to the triangularis sterni muscle, and to the posterior surface of the sternum. These small vessels form with offsets from the superior phrenic, bronchial, and intercostal arteries a fine wide-meshed network beneath the pleura, to which Turner has given the name of *subpleural mediastinal plexus* (Brit. and For. Med. Chir. Rev., Jan., 1865).

(*c*) The *anterior intercostal arteries*, two in each of the upper six spaces, arise from the internal mammary, either separately, or by a trunk common to the two, which soon divides. The arteries pass outwards, at first between the pleura and the internal intercostal muscles, and afterwards between the two layers of intercostals; they lie, one near the upper and one near the lower rib, and inosculate with the corresponding branches derived from the aortic intercostals. These branches supply the intercostal and pectoral muscles, and give some offsets to the mamma and integument.

(*d*) The *anterior* or *perforating* branches pass forwards through the upper six intercostal spaces, and turning outwards ramify partly in the pectoralis major, and partly in the integument on the front of the chest. Those placed nearest to the mammary gland supply that organ, and in the female they are of comparatively large size, especially during lactation. Some small offsets ramify on the sternum.

(*e*) The *musculo-phrenic artery*, the outer of the two branches into which the internal mammary divides, inclines downwards and outwards behind the cartilages of the asternal ribs, perforating the attachment of the diaphragm at the eighth or ninth cartilage, and becoming gradually reduced in size as it reaches the tenth or eleventh intercostal space. It gives branches backwards into the diaphragm; others, which pass outwards to form the anterior intercostals of the lower spaces, and are disposed precisely like those which are derived higher up from the main trunk; and some which descend into the abdominal muscles.

(*f*) The *abdominal branch*, or *superior epigastric artery*, descends between the sternal and costal portions of the diaphragm into the wall of the abdomen, where it lies at first behind the rectus, between the d **its sheath ; afterwards**, entering the muscle, the artery in its substance, and anastomoses with the epigastric artery xternal iliac. It supplies branches to the broad muscles of the e skin, and to the diaphragm ; one offset runs forwards upon of the ensiform process, and anastomoses with that of the de ; and small twigs pass backwards into the falciform ligae liver and form communications with the hepatic artery.

.—The internal mammary artery is sometimes found connected at its the thyroid axis, or with one or both of the scapular arteries—these hed from the thyroid. It occasionally springs from the second or f the subclavian artery, the latter being the more frequent position In very rare instances it has been found arising from the axillary, ate, or the aorta. The trunk of the artery has been seen to cross the fifth (Hyrtl) or sixth (G. D. T.) costal cartilage.
al branch, of considerable size, occasionally comes off from the upper artery, and passes downwards and outwards, crossing several of the r inner surface, about mid-way between the spine and sternum. The mmary artery may likewise furnish a bronchial branch.

**rior intercostal artery** (**iv**).—This artery arises from the of the subclavian, generally behind the anterior scalenus on side, and immediately internal to that muscle on the left. course backwards and at first slightly upwards, it speedily he deep cervical branch, and then bends downwards in front of the first rib, to be distributed in the first and second interes. On the neck of the first rib, the artery is situated between oracic ganglion of the sympathetic internally and the anterior vision of the first dorsal nerve externally.
ches to the first and second intercostal spaces are distributed way as the intercostal arteries derived from the aorta (p. 431), the second space is frequently joined by an offset from the intercostal.

.—The superior intercostal artery has been found, in a few instances, om the vertebral artery or from the thyroid axis. It has also been descend between the necks of one or two ribs and the transverse procorresponding dorsal vertebræ ; and in one case, after arising from artery, it passed in addition through the foramen in the transverse prost cervical vertebra (R. Quain, pl. 22, fig. 5). This artery is sometimes, rarely, wanting. On the other hand it may be larger than usual, hree or even four spaces. It has been seen to furnish a lateral branch n the inner surface of the ribs, similar to that occasionally derived ernal mammary artery (Blandin, "Anat. d. Régions," 2nd Ed., 250).

**p cervical artery** (fig. 243, 6), often described as a separate the subclavian, arises in most cases from the superior intersembling the posterior branch of an aortic intercostal artery, ckwards in the interval between the transverse process of the l vertebra and the first rib, to reach the posterior aspect of here it ascends under cover of the complexus muscle, and n the semispinalis colli, to the level of the axis. Its branches surrounding muscles, and anastomose with offsets of the he cervical branch of the occipital, and the ascending cervical

—The deep cervical artery sometimes arises separately from the subre rarely from the posterior scapular. It occasionally passes back sixth and seventh cervical vertebræ, and sometimes between the first and second dorsal, or even below the second. It has been seen to pass between the first rib and the transverse process of the first dorsal vertebra. The artery is not unfrequently supplemented by a branch of the ascending cervical artery, turning backwards between two of the cervical transverse processes; or by an enlarged dorsal branch from the superior intercostal artery in the first space; or in rare instances by an offset from the posterior scapular or inferior thyroid artery.

### SURGICAL ANATOMY OF THE SUBCLAVIAN ARTERIES.

The depth of the subclavian artery, its intimate and numerous connections with important parts, and the large size of its branches, render operations on this vessel peculiarly difficult.

The *third division* of the artery, situated beyond the anterior scalenus muscle, is the part which is most favourably circumstanced for the application of a ligature, inasmuch as the vessel is here nearest to the surface, and the spot selected is remote from the origin of the large branches. The artery is generally easy of access above the clavicle while the parts are in their natural position, but when they are displaced by an aneurism in the axilla, the clavicle may be so much elevated by the tumour as to be placed in front of the vessel, or even above it; and such a condition may require special modifications of the operation.

In the operation of passing a ligature round the third part of the subclavian artery, an incision is made a little above and parallel to the middle third of the clavicle, and in doing this, if the integument be drawn downwards over the clavicle, the parts covering the bone may be divided with freedom.

Along with the integument, the platysma and some descending superficial nerves are divided in this incision, but no vessel is endangered, except in those rare instances in which the cephalic vein or the external jugular crosses over the clavicle. It will, in some cases, be an advantage to add a short vertical incision, directed downwards to the middle of the horizontal one. Should the clavicular attachment of the sterno-mastoid or trapezius muscle be broader than usual, so that the interval between the two is insufficient for the farther steps of the operation, a portion of one, or even of both muscles, must be divided.

The external jugular vein, joined by the veins from the shoulder, is usually over the artery, and it must be held aside, or it may be necessary to divide it. If divided, the lower end of the vessel requires the application of a ligature as well as the upper one, in consequence of the reflux of blood from the subclavian vein, and the danger of air being drawn into the circulation. The omohyoid muscle will also be drawn upwards if necessary. The artery is now covered only by the areolar tissue of the supraclavicular fossa, and a layer of the deep cervical fascia (upper part of the axillary sheath), and in making the deeper dissection to reach the vessel, it will be best to divide these structures cautiously with a director or some blunt instrument, in order to avoid wounding the veins which pass inwards above the clavicle. At this stage of the operation the anterior scalenus muscle should be sought for, as it forms the best guide to the artery. This will be found descending nearly vertically behind the clavicular head of the sterno-mastoid, and if the finger be carried down along the outer border of the muscle, it will pass over the front of the artery, and reach the more or less prominent scalene tubercle on the upper surface of the first rib, which in cases of difficulty is of service as a farther guide to the vessel. The part of the artery to which the ligature is to be applied, is placed above, and at the same time somewhat to the outer side of and behind the tubercle. The nerves of the brachial plexus are here very close to the artery, and great care is necessary in separating the lowest trunk from the vessel. The artery is to be distinguished by its becoming flattened beneath the finger, while the nerves have a rounded cord-like feel, and (in the living subject) by its pulsation, although it is to be observed that this movement is frequently transmitted to the adjacent nervous trunk owing to the close connection of the two structures. The needle should be passed from behind forwards (C. Heath) in order to avoid the nerves, as the vein is placed at some little distance below and in front of this [illegible] of the artery, and ordinarily does not come into view during the operation [illegible] nerve to the subclavius may be exposed on the front of the artery, and if [illegible] to be carefully preserved, since it not unfrequently furnishes an accessory [illegible] to the phrenic nerve. The latter nerve itself has also been seen crossing the [illegible] part of the artery.

[illegible]th reference to the choice of the exact place at which the ligature is to be [illegible]d round this part of the artery, it should always be borne in mind that in the [illegible]jority of cases a considerable branch is given off from the main trunk in the [illegible]diate neighbourhood of the outer border of the scalenus muscle. This [illegible]ch is most frequently the posterior scapular; but in rarer cases it may be the [illegible]ficial cervical or suprascapular, or even the internal mammary.

[illegible]he *second division* of the subclavian artery is the part which rises highest in [illegible] neck, and on this account it may be advantageously selected for the application [illegible] of a ligature when the vessel is difficult of access beyond the muscle. The [illegible]ef objections to operating on this part of the artery arise from the contiguity [illegible] the large branches, and its close connection with the pleura. The steps of the [illegible]ation are similar to those described above, but the primary incision is made [illegible]ewhat farther inwards, and it will be necessary to divide the clavicular head [illegible] the sterno-mastoid and the scalenus anticus muscles. In doing this, care must [illegible] taken not to injure the anterior jugular vein and the phrenic nerve, and it is [illegible]ther advisable not to carry the incision through the whole breadth of the [illegible]lenus, but to leave the inner portion of the muscle undivided, in order to avoid [illegible]nding the internal jugular vein or the branches of the thyroid axis.

Difficulties may arise from the occurrence of an unusual position of the artery, [illegible] when it passes through the substance of the anterior scalenus, or when it is in [illegible]nt of that muscle; but such cases are of very rare occurrence.

The *first part* of the subclavian artery on the left side may be said to be [illegible]ccessible for the application of a ligature, in consequence of its depth and its [illegible] connection with the lung and other important structures, such as the internal jugular and innominate veins, and the thoracic duct.

On the right side, though deeply placed and closely connected with important parts, the first division of the subclavian artery may be tied in the interval between the common carotid artery and the internal jugular vein without extreme difficulty. But inasmuch as the distance between the bifurcation of the innominate on the one hand, and the origin of the vertebral artery on the other, seldom measures more than an inch, and is often much less, the success of the operation is exceedingly doubtful.

In order to place a ligature on the portion of the right subclavian artery here referred to, it is necessary to divide the three muscles which cover it, together with the layers of fascia between and beneath them. In doing this the anterior jugular vein must be avoided, and the suprasternal branch of the suprascapular artery will probably require to be secured. In the farther steps of the operation, the exact relations of the artery to the internal jugular vein, the pneumo-gastric nerve, and the pleura, are to be well kept in view.

It is to be remembered also that the first part of the right subclavian artery is occasionally more deeply placed than usual; as in those cases in which it springs from the back part of the aortic arch, or, more frequently, when it merely separates from the innominate behind the carotid.

The circulation in the subclavian artery may be arrested by pressure directed backwards and downwards in the supraclavicular fossa, so as to compress the third part of the vessel against the subjacent first rib.

*Collateral circulation.*—After ligature of the third part of the subclavian artery, blood is supplied to the upper limb through the anastomoses upon the scapula between the suprascapular, posterior scapular and subscapular arteries, and those formed by branches of the internal mammary and intercostal arteries with the thoracic branches of the axillary artery. After ligature of the first part of the artery, blood is conveyed to the distal portion of the trunk mainly by the vertebral artery, to a less extent by the inferior thyroid, internal mammary and superior intercostal arteries: the axillary artery receives blood also through the anastomoses formed by its thoracic branches, and the fore part of the thoracic wall is supplied by the intercostal and epigastric arteries.

### AXILLARY ARTERY (I).

The axillary artery is that part of the artery of the upper limb which extends from the outer border of the first rib to the lower margin of the teres major muscle. In this course it passes through the axilla, lying to the inner side of the shoulder-joint and upper part of the humerus, and its direction varies with the position of the limb, being curved downwards, or upwards, or being straight, according as the arm hangs by the side, or is elevated to a greater or less degree. With the arm raised to the level of the shoulder, a line drawn from the most prominent part of the clavicle to the inner side of the eminence formed by the biceps and coraco-brachialis muscles will indicate the position of the vessel.

The axillary artery is crossed in front by the pectoralis minor muscle, and is thus conveniently divided into three parts: the first part lying above the pectoralis minor, the second part being behind that muscle, and the third part beyond it.

In the *first part* of its course the artery is deeply placed, being covered by the pectoralis major, by a quantity of areolar and fatty tissue, and by a prolongation of the costo-coracoid membrane, as well as by the lower part of the subclavius muscle when the shoulder is depressed. This part of the artery is also invested by the axillary sheath, a membranous structure continued downwards from the deep cervical fascia (p. 289), and surrounding both the trunks of the vessels and the brachial plexus of nerves. It rests upon the first intercostal space and the first digitation of the serratus magnus. The *axillary vein* lies to the inner side and somewhat in front of the artery, and the *cephalic* and *acromio-thoracic veins* cross it to reach the main trunk. The *nerves of the brachial plexus* are to the outer side, and the *posterior thoracic nerve* passes down behind it.

In the *second part* of its course the artery is covered in front by the pectoralis major and minor muscles: the *vein* is on its inner side, and the *three cords of the brachial plexus* are placed one on the outer side, the second behind, and the third on the inner side, the last intervening between the artery and vein.

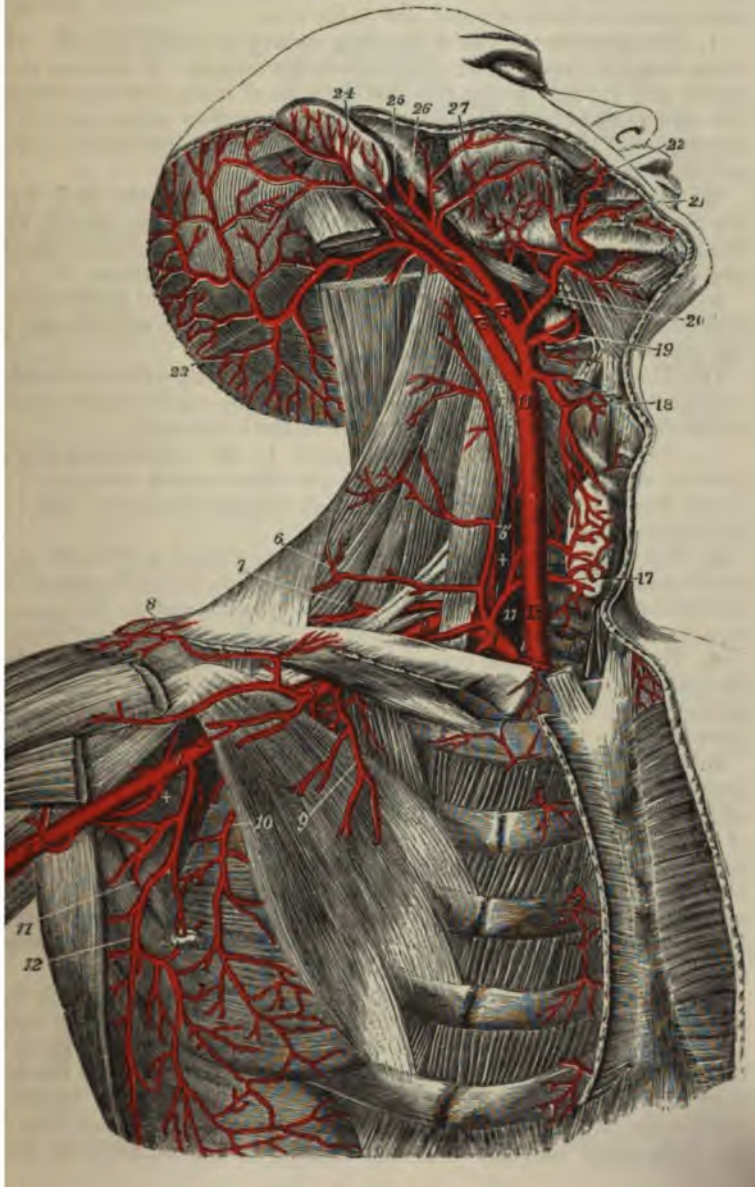
The *third part* of the axillary artery is covered anteriorly for the upper half of its extent by the pectoralis major muscle; in its lower half it is superficial, being placed immediately beneath the deep fascia of the arm, and here the flow of blood in the vessel may be readily controlled by pressure directed from within outwards against the humerus. It rests upon the subscapularis muscle and the tendons of the latissimus dorsi and teres major; and on its outer side is the coraco-brachialis muscle.

The *axillary vein* is still on its thoracic side, and the lower portion of the artery is accompanied also by one or both of the *brachial venæ comites*. The nerves resulting from the division of the brachial plexus are disposed around the artery, as follows, viz., behind are the *circumflex* and *musculo-spiral*; to its inner side the *ulnar* (between the artery and vein), and the *small internal cutaneous* (internal to the vein); to its outer side the

Fig. 246.—THE CAROTID, SUBCLAVIAN, AND AXILLARY ARTERIES (from Tiedemann). ½

The great pectoral, the sterno-mastoid, and the sterno-hyoid and sterno-thyroid muscles have been removed; the front part of the deltoid has been divided near the clavicle. *Subclavian artery and its branches.*—1, first part of the subclavian artery giving rise to the thyroid axis and internal mammary, and also to +, the vertebral artery; 2, third part of the subclavian artery; 3, first part of the axillary artery; 4, third part of the axillary artery; 5, commencement of the brachial artery; 6, superficial cervical artery, g off in this instance 6′, the ascending cervical branch ; 7, posterior scapular y, arising from the subclavian behind the scalenus anticus ; 8, acromial branch of the nio-thoracic ; 9, superior thoracic, in this case of large size ; 10, long thoracic artery the pectoralis minor muscle ; +, posterior circumflex branch of the axillary artery anterior circumflex is seen rising from the opposite side of the same part of the ry trunk) ; 11, dorsal scapular artery, passing backwards between the subscapularis eres major muscles ; 12, continuation of the subscapular artery. For the explana- f the references 13 to 27, see p. 374.

Fig. 246.



[illegible] while the large internal cutaneous is [illegible] the artery and the inner head of the median crosses it [illegible] in front.

Branches.—The branches of the axillary artery are very variable in their number and mode of origin. They comprise thoracic branches distributed to the muscles of the chest, the subscapular branch to the [illegible] and circumflex branches to the upper part of the arm. Small branches which are also given to the serratus magnus, subscapularis and [illegible] muscles, and to the [illegible].

1. The **superior or short thoracic artery** is a small branch, which arises near the lower border of the subclavius muscle. It inclines downwards and inwards across the first intercostal space, and terminates in the two pectoral muscles, giving off also branches which supply the upper part of the serratus magnus and the subjacent intercostal muscles, and anastomose with the intercostal arteries.

2. The **acromio-thoracic artery**, of considerable size, and by far the most constant of the thoracic branches of the axillary artery, arises from the fore part at the upper border of the pectoralis minor muscle, and soon divides into branches which take different directions.

The acromial branches pass partly in the deltoid and partly through that muscle to the upper surface of the acromion, and anastomose with the suprascapular and posterior circumflex arteries.

The humeral branch passes down in company with the cephalic vein in the interval between the pectoralis major and deltoid muscles, and is distributed to their margins and to the integument.

The thoracic branches are distributed to the serratus magnus and pectoral muscles, and anastomose with the other thoracic arteries.

The clavicular branch, very small, passes upwards to the subclavius muscle.

3. The **long thoracic artery** (external mammary) is directed downwards and inwards along the lower border of the pectoralis minor, and is distributed to the serratus and pectoral muscles, and to the mamma, forming anastomoses with branches of the intercostal arteries.

4. The **alar thoracic** branch is a very small vessel and not constant, its place being frequently supplied by branches from the thoracic and subscapular arteries. It is distributed to the lymphatic glands and the fatty tissue in the axilla.

5. The **subscapular artery** (iv), the largest branch of the axillary artery, arises near the lower border of the subscapularis muscle, along which it proceeds downwards and backwards, towards the inferior angle of the scapula, accompanied by the long subscapular nerve. It soon becomes considerably diminished in size, owing to its giving off a large branch to the dorsum of the scapula, and it terminates in branches to the subscapularis, serratus magnus, teres major and latissimus dorsi muscles. Its final ramifications anastomose with the long thoracic, the intercostal, and the posterior scapular arteries.

The *dorsal* branch leaves the subscapular artery about an inch from its origin, and is commonly larger than the continuation of the vessel. Directed backwards through the triangular interval bounded above by the subscapularis, below by the teres major, and externally by the long head of the triceps muscle, and turning closely round the border of the scapula, which is frequently grooved to receive it, it passes between the [illegible] minor and the bone and ramifies in the infraspinous fossa, where it anastomoses with the suprascapular and posterior scapular arteries.

The dorsal scapular artery gives off, as it passes through the triangular space, one or two slender *ventral* branches, which ramify in the subscapular fossa beneath the subscapularis muscle, and anastomose with twigs from the suprascapular and posterior scapular arteries; and a considerable *descending* branch which runs in the groove between the origins of the teres minor and major, supplying both muscles, to the lower angle of the scapula. Small offsets are also furnished to the long head of the triceps and the hinder part of the deltoid muscle.

Fig. 247

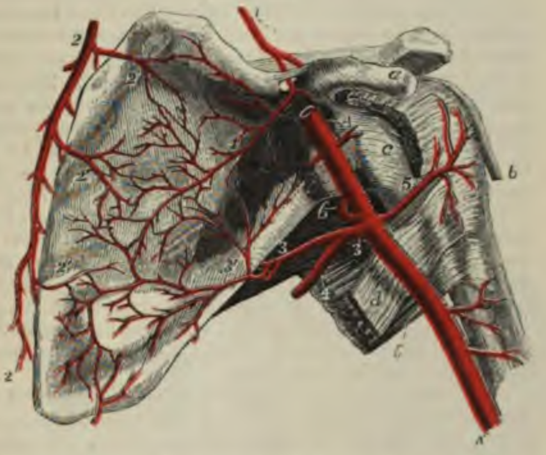


Fig. 247. — ANASTOMOSES OF THE ARTERIES ON THE VENTRAL SURFACE OF THE SCAPULA, &c. (from R. Quain). ⅓

*a*, coracoid process; *b*, tendon of the long head of the biceps; *c*, capsular ligament of the shoulder-joint; *d*, tendon of the latissimus dorsi; *e*, teres major; A, axillary, and A', brachial artery; 1, suprascapular artery, giving off, as it passes over the ligament into the supraspinous fossa, 1', its ventral branch, which descends through the notch and ramifies in the subscapular fossa; 2, 2, posterior scapular artery; 2', 2', its ventral branches; 3, 3, stem of the subscapular artery at its origin from the axillary, continued into the dorsal scapular artery, which is turning to the back of the scapula, and gives off, 3', its ventral branch, proceeding to anastomose with the ventral branches of the suprascapular and posterior scapular arteries; 4, thoracic branch of the subscapular artery; 5, anterior circumflex artery; 6, posterior circumflex, in this case rising above the subscapular, and passing back through the quadrilateral intermuscular space.

**6**. The **posterior circumflex artery**, a considerable vessel but smaller than the subscapular, immediately below which it arises, is directed backwards in company with the circumflex nerve, passing through the quadrilateral space between the teres muscles, the humerus, and the long head of the triceps, and therefore separated by the last from the dorsal scapular artery. It winds round the humerus, and terminates by ramifying in the deltoid muscle, giving branches also to the shoulder-joint, to the long and outer heads of the triceps, and to the skin, and anastomosing with the anterior circumflex and acromio-thoracic arteries, as well as with the superior profunda branch of the brachial.

**7**. The **anterior circumflex artery**, much smaller than the posterior, arises nearly opposite that from the outer side of the axillary artery. It passes outwards, beneath the inner head of the biceps and the coracobrachialis muscles, and resting on the fore part of the humerus, until it reaches the bicipital groove. There it divides into two branches, one of which ascends in the groove with the long head of the biceps to the head of the bone and the capsule of the joint; the other continues outwards, and anastomoses with the posterior circumflex branch.

**Varieties.**—The most important variety in the trunk of the axillary artery consists in its giving off a much larger branch than usual,—an arrangement which has been observed in the proportion of one out of every ten cases (R. Quain). In one set of cases, this large branch is continued as one of the arteries of the fore-arm; most frequently the radial (about 1 in 33), sometimes the ulnar (1 in 72), less frequently a vas aberrans, and very rarely the interosseous artery. In another set of cases, the large branch gives origin to the subscapular, the two circumflex, and the two profunda arteries of the arm; but sometimes only one of the circumflex, or only one of the deep humeral arteries arises from it. In the second class of cases the divisions of the brachial plexus of nerves surround the common stem of the branches instead of the main vessel. This disposition may with probability be explained by supposing that the stem of the branches was originally the brachial artery, but that in early life it had become obstructed in its distal part, and that there had become developed in its place, as an apparent brachial artery for the supply of the lower portions of the limb, a vas aberrans, such as is sometimes seen arising from the brachial artery, and uniting wih one of its branches.

The superior thoracic artery is so frequently given off by the acromio-thoracic, that some anatomists have described that as the normal arrangement, giving the common trunk the name of *thoracic axis*. The long thoracic artery often rises from the acromio-thoracic, or is replaced by enlargement of the normal branches of that artery, and not unfrequently is given off by the subscapular.

The subscapular artery is often united at its origin with the posterior circumflex; and, on the other hand, the dorsal scapular branch sometimes springs directly from the axillary artery.

The posterior circumflex artery is sometimes removed from the axillary to the superior profunda branch of the brachial, in which case it ascends behind the teres major muscle. In another class of cases, not quite so numerous, the posterior circumflex gives off one or more branches usually derived from other sources: as for example (placing them in the order of frequency), the anterior circumflex, the superior profunda, the dorsal scapular, the anterior circumflex and superior profunda together, or some other rarer combination of those vessels (R. Quain, *op. cit.*, p. 230). The posterior circumflex is sometimes double; and so is the anterior, but more seldom.

An accessory *external mammary* branch is not unfrequently present, arising from the axillary beyond the circumflex arteries, and running downwards and inwards to the side of the chest behind the long thoracic. The following branches, usually derived from the subclavian artery, have been seen in rare cases to arise from the axillary, viz., internal mammary, suprascapular, and posterior scapular; as have also the superior profunda, inferior profunda, and anastomotic arteries, normally branches of the brachial.

The third part of the axillary artery is frequently crossed by a muscular slip (axillary arch) passing from the latissimus dorsi to the anterior wall of the axilla (p. 193).

### SURGICAL ANATOMY OF THE AXILLARY ARTERY.

This artery is usually tied in the third part of its course, as it lies upon the tendon of the latissimus dorsi. The limb having been carried away from the chest, an incision is made parallel to and a little behind the anterior fold of the axilla. On cutting through the deep fascia, the vein is exposed, and by drawing this downwards the artery is brought into view, surrounded by the nerves from the brachial plexus. The ligature is to be passed from within outwards. Another and simpler mode of operating is that recommended by Malgaigne, according to which the incision is made along the inner border of the coraco-brachialis muscle, and the median nerve then serves as a guide to the artery, while the vein is not exposed. In the rest of its course the artery is so deeply placed, and in such close relation with the vein and nerves, that an operation on the third part of the subclavian is both easier and more successful.

*Collateral circulation.*—After ligature of the third part of the axillary artery, the circulation in the upper limb is carried on by means of the anastomoses of the posterior circumflex and superior profunda arteries, and of smaller branches of the axillary and brachial arteries in the coraco-brachialis, biceps, and triceps muscles.

### BRACHIAL ARTERY (II).

The brachial or humeral artery, the continuation of the axillary, extends from the lower border of the teres major muscle to about a finger's breadth below the bend of the elbow, or to a point opposite the inner border of the neck of the radius, where it divides into the radial and ulnar arteries. The artery gradually inclines from the inner side to the fore part of the limb, lying in the depression along the inner border of the coraco-brachialis and biceps muscles; and a line drawn on the surface of the arm along this hollow will indicate the course of the vessel. To command the flow of blood through the artery at its upper part

Fig. 248.

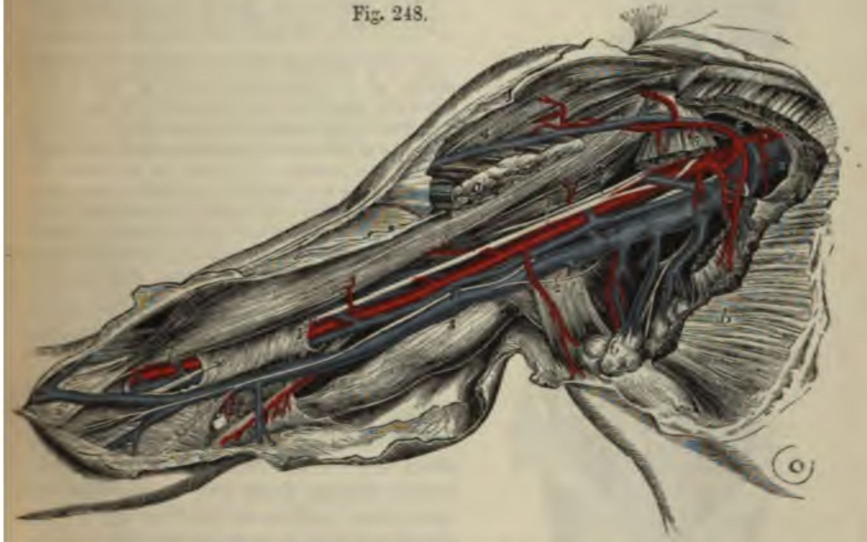


Fig. 248.—Dissection of the axilla and inner side of the arm to show the axillary and brachial vessels (from R. Quain). ¼

Portions of the pectoral muscles have been removed so as to expose the axillary vessels: *a*, insertion, and *b*, origin of the pectoralis major; 1, 1, axillary artery; 1′, placed on a part of the sheath of the brachial vessels, and 1″, on the lower part of the biceps muscle, point to the brachial artery surrounded by its venæ comites; 2, 2, axillary vein; 3, 3, basilic vein; the upper figure is placed on the triceps muscle, the lower on the fascia near the junction of the ulnar veins; on the basilic vein are seen the ramifications of the internal cutaneous nerve; +, +, median nerve; 4, on the deltoid, and 4′, near the clavicular part of the great pectoral muscle, mark the cephalic vein joining the axillary vein; 5, 5, placed on the divided portions of the pectoralis minor, point to the origin and branches of the acromio-thoracic artery; 6, placed on a group of axillary glands, indicates the alar thoracic and subscapular vessels; 7, placed on the trunk of the axillary vein, points to one of the brachial venæ comites, which, being joined by the other higher up, passes into the axillary vein; the ulnar nerve is seen passing behind the basilic vein towards the inner condyle; near 1, placed on the coraco-brachialis muscle, is seen the musculo-cutaneous nerve before it passes through that muscle; near 2, placed on the tendon of the latissimus dorsi muscle, a portion of the nerve of Wrisberg.

pressure should be directed outwards, while over the lower end of the vessel the pressure should be made from before backwards.

The brachial artery lies beneath the integument and fascia of the arm as far as the bend of the elbow, where it sinks deeply in the interval between the pronator teres and supinator longus muscles, and is covered by the semilunar fascia of the biceps. It rests at first, for a short distance, on the long head of the triceps, the musculo-spiral nerve and the superior profunda artery intervening, and then on the inner head of the same muscle; at the middle of the arm it crosses the insertion of the coraco-brachialis muscle, and in the rest of its course it lies on the brachialis anticus. On its outer side it is in apposition first with the coraco-brachialis, and afterwards and for the greater part of its length with the biceps, the inner border of one or both muscles overlapping it to a greater or less extent according to the muscular development of the individual.

Fig. 249.

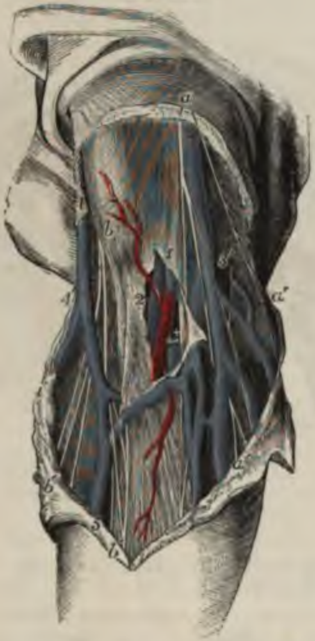


Fig. 249.—SUPERFICIAL DISSECTION OF THE BLOOD-VESSELS AND NERVES AT THE FRONT OF THE ELBOW (from R. Quain). $\frac{1}{2}$

*a*, two branches of the internal cutaneous nerve; *a′ a″*, descending twigs of the same nerve; *b*, placed over the biceps near its insertion and close to the external cutaneous nerve; *b′*, *b′*, branches of this nerve descending along the outer part of the forearm; 1, placed on the fascia of the arm near the bend of the elbow, above the place where it has been opened to show the lower part of the brachial artery with its venæ comites, of which one is entire, marked 2, and the other has been divided; +, is placed between the artery and the median nerve; 3, basilic vein; 3′, 3′, ulnar veins; 4, cephalic vein; 4′, radial vein; 5, 5, median vein; 3′, 5, median-basilic vein; 4′, 5, median-cephalic vein.

*Relation to veins.*—*Venæ comites* are in close contact with the brachial artery, short transverse branches of communication passing from one to another, so as at many points to encircle it. The *basilic vein* is placed to the inner side of the artery, but is separated from it by the deep fascia of the limb in the lower half or more, according to the level at which the vein perforates that membrane; and at the bend of the elbow the *median-basilic vein* crosses over the artery, the semilunar fascia of the biceps lying between them.

*Relation to nerves.*—The *median nerve* descends in contact with the artery, lying on its outer side in the upper half of the arm, directly in front of it below the middle, and on the inner side at the elbow. The *large internal cutaneous nerve* accompanies the artery, being placed over or to the inner side of the vessel, until it pierces the fascia about the middle of the arm. The *ulnar nerve* lies on the inner side of the artery as far as the insertion of the coraco-brachialis; and the *musculo-spiral nerve* is behind it for a short distance at its upper end.

BRANCHES.—In addition to the four named branches which are described

Fig. 250.—Superficial view of the arteries of the front of the arm, forearm and hand (from Tiedemann). ¼

*a*, deltoid muscle; *b*, biceps; *b'*, its semilunar fascia; *c*, long head of the triceps; *c'*, its inner head; *d*, pronator teres; *e*, flexor carpi radialis; *f*, palmaris longus; *f'*, its tendon spreading in the upper part of the palmar fascia, from which, on the inner side, the palmaris brevis muscle is seen rising; *g*, flexor carpi ulnaris; *h*, supinator longus; *i*, extensor carpi radialis longior; *l*, extensor ossis metacarpi pollicis; *m*, flexor sublimis digitorum; 1, placed on the tendon of the latissimus dorsi, the lower part of the axillary artery, continued into the brachial; 2, superior profunda; 3, inferior profunda; 4, anastomotic; 5, near the division of the brachial artery into ulnar and radial, indicates the origin of the radial recurrent artery; 5', lower part of the radial artery, where it gives off the superficial volar, and turns round the wrist; 6', the lower part of the ulnar artery, near the place where it passes down to form the superficial palmar arch; 7, the superficial volar, which joins it; 8, 8, 8, 8, digital branches of the superficial arch; 9, radialis indicis; on the thumb are seen the two branches of the princeps pollicis artery.

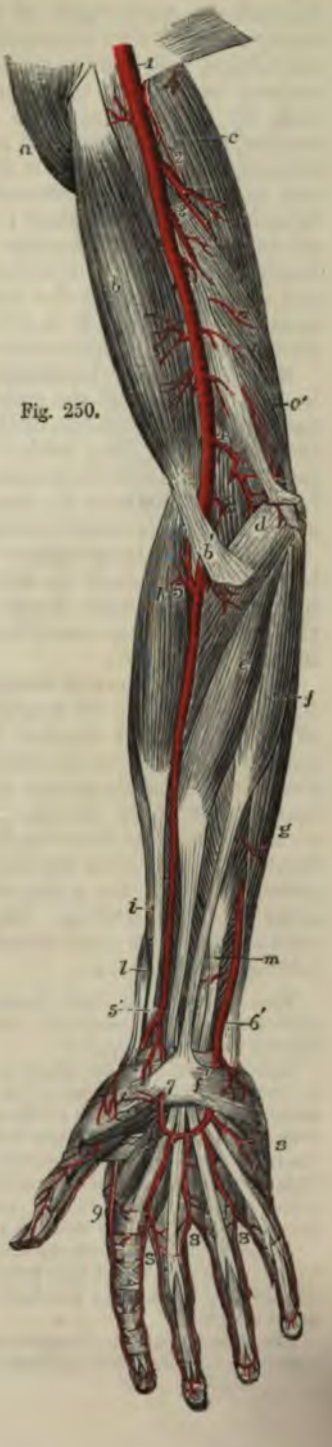


Fig. 250.

below, and which proceed backwards from the main trunk, the brachial artery gives small offsets to the integument of the arm, and a variable number of *muscular* branches, which pass forwards and outwards to the coraco-brachialis, biceps and brachialis anticus muscles; one more constant branch, arising from the upper part of the artery (sometimes from the superior profunda), passes outwards transversely in front of the humerus and terminates in the lower part of the deltoid muscle.

**1.** The **superior profunda artery** (**iv**), the largest of the branches, arises from the posterior part of the brachial artery, just below the border of the teres major, and inclines backwards as it descends to reach the interval between the inner and long heads of the triceps muscle. Accompanying the musculo-spiral nerve, it then winds round the back of the humerus, in the spiral groove, and under cover of the outer head of the triceps. In its course it gives off several branches to the three heads of the triceps; one offset passes upwards between the long and outer heads of that muscle, to anastomose beneath the hinder part of the deltoid with the posterior circumflex artery; and another of considerable size descends in the inner head of the triceps, and joins in the anastomoses above the elbow-joint. Much reduced in size as it arrives at the outer side of the humerus, the artery ends by dividing into two branches; the one of which, much the smaller, passes on with the musculo-spiral nerve through the external intermuscular septum, into the interval between the supinator longus and brachialis anticus muscles, and anastomoses with the recurrent branch of the radial artery; while the other descends along the back of the external intermuscular septum, and anastomoses behind the outer condyle of the humerus with the posterior interosseous recurrent artery, and across the back of the bone with the inferior profunda and anastomotic arteries (fig. 253, p. 417). Small twigs are also given to the skin along with the external cutaneous branches of the musculo-spiral nerve.

**2.** The **inferior profunda artery,** of small size, arises from the brachial artery about the middle of the arm, and is directed to the back part of the inner condyle of the humerus. It descends in company with the ulnar nerve, lying behind the internal intermuscular septum on the inner head of the triceps muscle, to which it gives branches, and it ends by anastomosing with the posterior recurrent branch of the ulnar artery, and with the anastomotic branch of the brachial.

**3.** The **medullary artery** of the humerus is a small branch given off by the brachial about the middle of the arm, or by one of its collateral branches. It inclines downwards, enters the canal in the humerus near the insertion of the coraco-brachialis muscle, and is distributed in the interior of the bone.

**4.** The **anastomotic artery** is a very constant branch of moderate size. Arising from the brachial artery about two inches above the bend of the elbow, it is directed backwards and inwards on the brachialis anticus muscle, above the inner condyle of the humerus, and, after perforating the intermuscular septum, turns outwards behind the bone, under cover of the triceps muscle, to form with the superior profunda an arch across the humerus, immediately above the olecranon fossa. In front of the humerus the anastomotic artery furnishes a branch which ramifies beneath the pronator teres, and anastomoses with the anterior ulnar recurrent branch. Behind the inner condyle another offset joins with the posterior ulnar recurrent, and several branches are given to the joint and the muscles.

**Varieties.**—From their comparative frequency, and surgical interest, the peculiarities of the brachial artery, especially those which affect its trunk, deserve particular attention.

*Course.*—The brachial artery sometimes, though rarely, descends, accompanied by the median nerve, towards the inner condyle of the humerus, and regains its usual position at the bend of the elbow by passing forwards underneath a fibrous arch, from which the pronator teres in these cases arises, and which descends to the inner condyle from the occasional prominence called the supracondylar process. This variety resembles the condition normally existing in the Felidæ and many other animals, in which the brachial artery and median nerve are directed forwards and outwards through a supracondylar foramen (see p. 91).

*Division.*—As an extremely rare condition, the artery has been found dividing near its commencement into two vessels, which unite again near the elbow, forming a single trunk from which the radial and ulnar arteries are given off in the usual manner.

The most frequent change from the ordinary arrangement of the brachial artery is connected with its division into terminal branches.

Out of 481 examples recorded by R. Quain, the vessel was found in 386 t
divide at its usual position, a little below the elbow-joint. In one case only (an
that complicated by another peculiarity, viz., the existence of a *vas aberran*

Fig. 251.

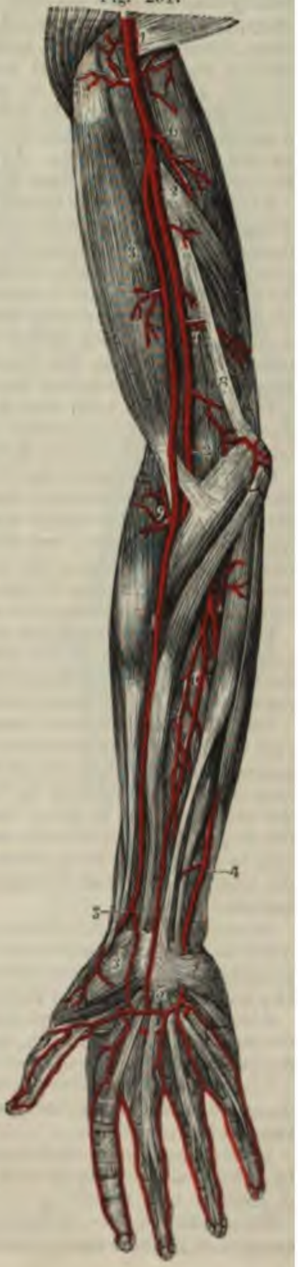


Fig. 251.—High origin of the radial artery from the brachial, and an enlarged median artery in the forearm (from Tiedemann). ¼

1, on the tendon of the latissimus dorsi, points to the upper part of the brachial artery; 2, the brachial artery (ulnar-interosseous) after giving off the radial; 3, the radial, rising in the upper third of the arm and descending in its usual situation in the forearm; 3′, its superficial volar branch; 4, the ulnar artery in its usual course, forming at 5, the superficial palmar arch, from which three of the palmar digital arteries and the princeps pollicis take origin; the radial supplying the branches to the index finger and one side of the middle finger; 6, superior profunda artery; 7, inferior profunda; 8, anastomotic; 9, recurrent radial; 10, anterior interosseous, giving an unusually large median branch which descends over the wrist to join the superficial palmar arch.

proceeding from the axillary to the radial) was the place of division lower than usual, being between two and three inches below the elbow-joint. In 64 cases the brachial artery divided *above* the usual point, at various heights upwards to the lower border of the axilla. The branch prematurely separated from the rest of the trunk in an early division is, in the proportion of nearly three cases out of four, the radial artery; sometimes the ulnar is the branch given off; that is to say, a branch corresponding to the ulnar in its distribution below the middle of the forearm separates from a trunk which afterwards divides into the normal radial artery and the interosseous of the forearm, which last is normally derived from the ulnar artery. Rarely the interosseous of the forearm, or a *vas aberrans* is the branch given off. In one instance, found in the dissecting-room of Glasgow University, the posterior interosseous artery of the forearm was thus given off.

The point at which the division took place in cases of high origin of one or other of the arteries of the forearm, without reference to the particular branch given off, was found to be most frequently in the upper, less so in the lower, and least so in the middle third of the arm. But the early division of the main artery of the upper limb may, as mentioned in connection with the varieties of the axillary artery, take place within the axilla, in which case it follows that the brachial portion of the vessel is replaced, throughout its whole extent, by two separate trunks. In 94 cases out of the 481 observed by R. Quain, or about one in five, there were two arteries instead of one in some part of the arm.

*The position of the two arteries*, in these cases, is also of surgical interest. Usually they are close together, occupying the ordinary position of the brachial artery, and the abnormal vessel is generally the more superficial; but the *radial* artery, when thus given off, in the arm, often arises from the inner side of the brachial, then runs parallel with the larger vessel (the brachial or ulnar-interosseous), and crosses over it, occasionally under it, opposite the elbow, still covered by the fascia. The radial artery has also been found, in a few instances, to perforate the fascia near the bend of the elbow, and run immediately under the skin for some distance. As a rare occurrence it passes behind the tendon of the biceps to its usual place in the forearm.

When the *ulnar* is the branch arising high, it often inclines from the position of the brachial, at the lower part of the arm, towards the inner condyle of the humerus. This vessel generally lies beneath the fascia as it descends, and superficial to the flexor muscles of the forearm, sometimes however crossing beneath the palmaris longus. It is occasionally placed between the integument and the fascia; and in one case only was it found by R. Quain beneath the muscles. In one instance occurring in the dissecting-room of Glasgow University, the ulnar artery given off from the brachial at the middle of the arm was observed to descend superficially behind the inner condyle.

The *interosseous*, after arising from the axillary or brachial artery, is commonly placed behind the main trunk, and, on reaching the bend of the elbow, passes deeply between the muscles to its usual position in the forearm.

Lastly, when the radial has arisen high in the arm, the remaining portion of the brachial (*ulnar-interosseous*) has occasionally been observed descending, accompanied by the median nerve, along the intermuscular septum towards the inner condyle of the humerus, and turning forwards round a supracondylar process to gain the usual position at the middle of the bend of the elbow. The interosseous trunk has also been seen to take a similar course when given off in the arm, as has also a vas aberrans joining the ulnar artery (fig. 252).

The two arteries occupying the place of the brachial are in some instances connected near the bend of the arm by an intervening trunk, which proceeds from the larger (or ulnar-interosseous) artery to the radial or the radial recurrent, and varies somewhat in its size, form, and course.

The *aberrant arteries*, "vasa aberrantia," alluded to above, are long slender vessels, which arise either from the brachial or the axillary artery, and end by joining one of the arteries of the forearm, or one of their branches. In eight cases out of nine, observed by R. Quain, this unusual vessel joined the radial; in the remaining case it joined the radial recurrent, which arose irregularly from the ulnar artery. Very rarely the aberrant vessel joins the ulnar. This peculiarity may be regarded as an approach to that condition in which there is division of the brachial artery and subsequent connection of its two parts by an intervening branch.

In most cases of high division of the brachial artery the condition of the vessels is not the same in the right and left arms. In 61 bodies in which the high division existed, it occurred on one side only in 43; on both sides, in different positions, in 13; and on both sides, in the same position, in the remaining 5.

A *median artery* of large size (pp. 419, 421) has also been seen arising from the brachial, and in one or two cases this vessel passed downwards over the muscles of the forearm to reach the palm of the hand.

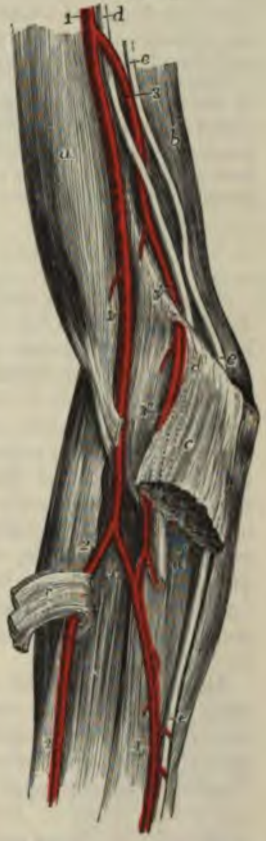
In a very few cases the three arteries of the forearm, radial, ulnar, and interosseous, have arisen together from the end of the brachial trunk, at the usual distance below the elbow.

*Relations.*—The brachial artery is occasionally covered in some part of the arm by a fleshy slip connected with the coraco-brachialis, biceps, brachialis anticus, or pronator teres muscle.

The median nerve sometimes passes behind, instead of in front of, the brachial artery, and in these cases it will be generally found that the axillary artery preiety referred to on p. 408, in which several of the large branches are common trunk.

–It has been already mentioned that the *superior profunda* may give : posterior circumflex artery, and that its own origin is sometimes o a branch arising from the axillary artery.

Fig. 252.



BERRANT ARTERY, LEAVING THE BRACHIAL DDLE OF THE ARM, PASSING WITH THE RVE THROUGH THE INTERNAL INTER-SEPTUM, AND JOINING THE ULNAR. (R.

uscle; *b*, triceps; *c*, *c*, divided pronator ′, median nerve, diverted from its usual assing with the aberrant artery through termuscular septum; *e*, *e*, *e*, ulnar nerve; ery, giving off the aberrant artery at the arm; 2, radial artery; 3, aberrant artery, an nerve crossing it, passing at 3′, through termuscular septum; 3″, the same farther mmunicating at 4′ with the first part of ry, 4.

*ior profunda* is occasionally absent, account has not been recognised by ists as a regular branch of the bra- It is frequently united at its origin erior profunda.

*omotic* artery is sometimes much re- e, and in that case the inferior pro- its place behind the humerus.

## ANATOMY OF THE BRACHIAL ARTERY.

al artery may be easily reached for on of a ligature in any part of its he middle third of the arm its position side of the biceps muscle, where its y be felt, is a sufficient guide for the om the thinness of the parts covering owever, and the proximity of superfi- specially the basilic, the integuments nust be divided with caution. When s been cut through, the median nerve mes into view, as it lies in front of Occasionally it is found necessary to divide some muscular fibres tery is reached.

er third of the arm, the median nerve being placed to the inner ery is more fully exposed after division of the fascia, but here care in passing the ligature round the artery, to avoid the venæ comites municating cross branches, which cling very closely to the artery.

very frequent occurrence of varieties in the mode of division of the ry into the vessels derived from it, the surgeon must be prepared for ions from the usual condition of the parts, and especially for the wo arteries in place of one in the lower third of the brachial region. the two arteries are most frequently close together and nearly parallel, e easy to tie both vessels, should this be rendered necessary by the e injury for which the operation is performed. But, as will be seen as previously been said of the abnormal forms of the brachial artery, of one or both the vessels may be subject to very considerable varia- ent instances; and in some of these, while one of the vessels is near the usual position, the other may be at some distance, as for example, when it passes beneath a supracondylar process of the humerus.

At the bend of the elbow, the brachial artery is exposed to the risk of injury during the operation of venesection, for which the median-basilic vein is commonly selected. This vein lies here in front of the artery, the semilunar fascia being stretched between them. Instances are known in which the artery has been wounded by the lancet transfixing the vein and fascia, and a communication has thus been established between the vein and artery. On this account the incision into the vein must be made with due care, and indeed the median-cephalic, if of sufficient size, may be selected for the operation.

*Collateral circulation.*—When the brachial artery has been tied in the middle of the arm, the superior profunda branch forms the principal channel through which the circulation is carried on, by means of its anastomoses with the radial recurrent, interosseous recurrent, and anastomotic arteries. If the ligature has been placed on the artery near the elbow, the inferior profunda and anastomotic arteries will assist by their communications with the ulnar recurrents.

### ULNAR ARTERY (III).

The ulnar artery, the larger of the two vessels into which the brachial divides, extends along the inner side of the forearm into the palm of the hand, where it forms the superficial palmar arch. In this course it inclines at first downwards and inwards, describing a slight curve, the convexity of which is directed inwards, and passes between the superficial and deep layers of muscles; somewhat above the middle of the forearm the artery comes into contact with the ulnar nerve, which was previously separated from it by a considerable interval, and thence descends vertically with the nerve towards the inner border of the palm of the hand. Lying along the radial border of the tendon of the flexor carpi ulnaris muscle, the ulnar artery reaches the outer side of the pisiform bone, where, still accompanied by the nerve, it passes over the cutaneous surface of the anterior annular ligament of the wrist into the palm of the hand. Its disposition in the hand will be separately described.

In the first half of its course through the forearm, the artery is deeply seated, being covered by the muscles arising from the inner condyle of the humerus, viz., pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum. From the middle of the forearm it is overlapped by the flexor carpi ulnaris till within an inch of the wrist, where it lies immediately under the fascia. Beneath the tendon of the flexor carpi ulnaris the artery is also covered by a thin layer of membrane by which it is bound down to the muscle beneath. At first the ulnar artery lies on the insertion of the brachialis anticus, then on the flexor profundus digitorum in the rest of the forearm, and lastly, on the annular ligament of the wrist. Below the point at which it emerges from under the flexor carpi ulnaris, the tendon of that muscle is on its inner or ulnar side.

*Relation to veins.*—The ulnar artery is accompanied by two veins (*venæ comites*) which are united by numerous cross branches.

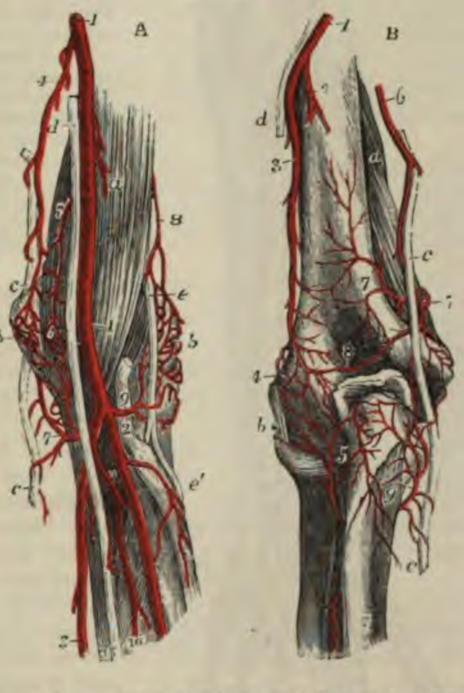
*Relation to nerves.*—The *median nerve* lies at first immediately on the inner side of the ulnar artery, but being directed down the middle of the forearm it soon passes over the vessel, separated from it at the point of crossing by the deep head of the pronator teres muscle. As the *ulnar nerve* descends behind the inner condyle of the humerus, it is separated from the ulnar artery by a considerable interval at the upper part of the ırm ; but as the vessel inclines inwards, it approaches the nerve, is accompanied by it in the lower half or more of its course—the e lying close to its inner side. The small *palmar cutaneous* branch ıe ulnar nerve descends upon the lower part of the artery.

ʀANCHES.—The ulnar artery in the forearm gives numerous *muscular* ıches, of small size, to the surrounding muscles, and the following ɪed offsets, viz. :—

. The **anterior ulnar recurrent artery**, a small branch, arches in- ds and upwards from the upper part of the ulnar artery, in front of inner condyle, lying on the brachialis anticus muscle, and covered by pronator teres, both of which muscles it partly supplies. It ends by ımunicating with the anastomotic branch of the brachial.

. The **posterior ulnar recurrent artery**, larger than the preced- , comes off a little lower down ; but not unfrequently the two vessels e by a short common trunk. The posterior recurrent runs inwards backwards beneath the flexor sublimis, and then ascends behind the er condyle. In the interval between that process and the olecranon ies beneath the flexor carpi ulnaris, and, passing between the heads of

Fig. 253.



253.—THE ANASTOMOSES ᴏꜰ THE ELBOW : A, FROM ʙEFORE ; B, FROM BEHIND (from R. Quain). ⅓

A. *a*, brachialis anticus mus- ; *b*, external condyle, covered the anastomoses of the su- rior profunda and radial re- rent arteries ; *c*, ulnar nerve ; median nerve ; *e*, musculo- ral nerve ; *e′*, its posterior erosseous branch ; its radial nch is cut short ; 1, brachial ery ; 2, radial artery ; 3, ar artery ; 4, inferior pro- da ; 5, anastomotic ; 6, terior ulnar recurrent, anasto- sing with the anterior de- nding branch of the anasto- tic ; 7, posterior ulnar re- rent, passing up behind the er condyle to anastomose with inferior profunda and pos- ior branch of the anastomotic ; anterior terminal branch of superior profunda ; 9, on tendon of the biceps muscle, nts to the radial recurrent ery ; 10, 10, interosseous ery and its anterior branch.

B. *a*, part of the brachialis icus muscle ; *b*, external ral ligament of the elbow- t ; *c*, ulnar nerve ; *d*, a ll part of the musculo-spiral nerve ; 1, superior profunda artery ; 2, branch which cends in the inner head of the triceps muscle ; 3, its posterior terminal branch ; 4, nches of the radial recurrent ; 5, posterior interosseous recurrent, passing up to anas- ose with the preceding and with the posterior ulnar recurrent ; 6, inferior profunda ; , anastomotic artery ; 8, anastomosis of the inferior profunda and anastomotic with superior profunda ; 9, posterior ulnar recurrent, passing up with the ulnar nerve to tomose with the inferior profunda and anastomotic.

Fig. 254.

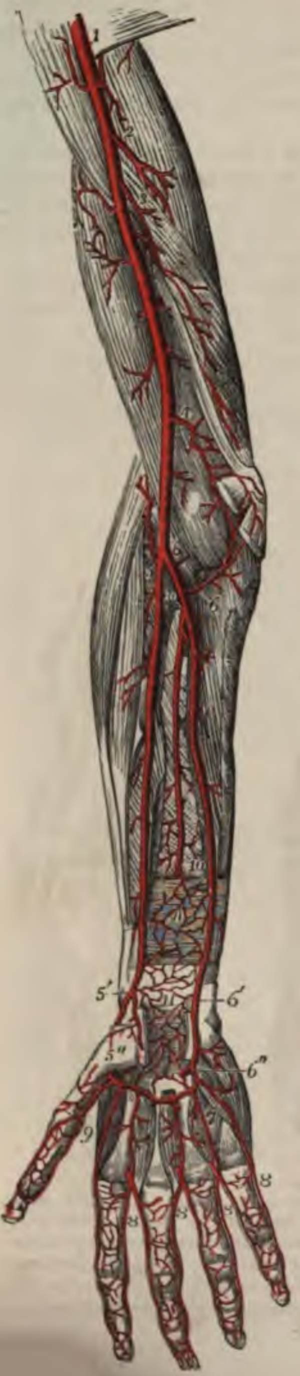


Fig. 254.—Deep anterior view of the arteries of the arm, forearm, and hand (from Tiedemann). ¼

The biceps, the muscles rising from the inner condyle, the supinator longus, the lower part of the flexor longus pollicis and flexor profundus digitorum, the anterior annular ligament, and the muscles of the ball of the thumb have been removed: *n*, pronator quadratus muscle; 1, lower part of the axillary artery continued into the brachial; 2, superior profunda; 3, inferior profunda; 4, anastomotic; 5, upper part of the radial artery and radial recurrent; 5', lower part of the radial artery, giving off the superficial volar branch; 5'', radial artery, emerging from between the heads of the abductor indicis muscle; 6, 6, upper part of the ulnar artery with the anterior and posterior ulnar recurrent branches; 6', ulnar artery, approaching the wrist and descending into the superficial palmar arch which has been cut short; 6'', deep branch of the ulnar artery uniting with the deep palmar arch; 7, (marked only on one) interosseous branches from the deep palmar arch joining the palmar digital arteries 8, 8, 8, which have been cut away from their origin from the superficial arch to near their division into the collateral digital arteries; the ulnar collateral of the little finger is rising in this instance from the deep palmar arch; 9, placed between the princeps pollicis and radialis indicis branches of the radial artery; 10, lower part of the anterior interosseous artery passing behind the pronator quadratus muscle; 11, anastomosis of the anterior carpal branches of the radial and ulnar arteries with twigs from the anterior interosseous artery and recurrent branches from the deep palmar arch.

this muscle along the ulnar nerve, supplies branches to the muscles, to the elbow-joint, and to the nerve itself. This branch communicates with the inferior profunda, the anastomotic, and, over the olecranon, also with the posterior interosseous recurrent.

**3.** The **interosseous** or **common interosseous artery (iv)**, the next and largest branch, is a short trunk which arises from the ulnar artery about an inch from its commencement, and inclines backwards to reach the upper border of the interosseous membrane, where it divides into the anterior and posterior interosseous arteries.

The **anterior interosseous artery** descends upon the front of the interosseous membrane, accompanied by the interosseous branch of the median nerve and venæ comites, and overlapped by the contiguous borders of the flexor fundus digitorum and flexor longus pollicis muscles. It continues course directly downwards as far as the upper border of the pronator adratus muscle, then pierces the interosseous membrane, and descends the back of the carpus. It gives off the following branches :—

(a) The *median artery*, a long slender branch, which accompanies the dian nerve and sends offsets into its substance, and to the flexor limis digitorum. This artery is sometimes much enlarged, and ists in supplying the hand as will be hereafter noticed.

(b) *Muscular* branches to the flexor profundus, flexor longus pollicis, l pronator quadratus muscles, and others which perforate the interеous membrane to supply the extensors of the thumb.

(c) The *medullary arteries* of the radius and ulna, which enter the amina in those bones to be distributed in their interior.

(d) An *anterior communicating* branch, given off before the artery rces the interosseous membrane, and descending beneath the pronator dratus muscle to anastomose with the anterior carpal arteries.

e) *Terminal* twigs anastomosing with the posterior carpal arteries.

The **posterior interosseous artery**, passing backwards through the rval between the oblique ligament and the upper border of the interous membrane, appears on the back of the forearm between the inator brevis and extensor ossis metacarpi pollicis muscles, and gives here its recurrent branch. Continuing its course downwards between superficial and deep layers of extensor muscles, to both of which it ributes branches, it reaches the back of the wrist much diminished size, and ends by anastomosing with the anterior interosseous and terior carpal arteries.

The *posterior interosseous recurrent artery* passes directly upwards, ered by the anconeus, to reach the interval between the olecranon l external condyle, where it divides into several offsets which anasiose with the superior profunda, the posterior ulnar recurrent and the ial recurrent arteries.

. The **posterior ulnar carpal** branch, of variable size, arises a little ve the pisiform bone, and winds back under the tendon of the flexor pi ulnaris to gain the dorsal surface of the carpus. It gives a small *acarpal* branch (sometimes derived separately from the ulnar) which s along the ulnar side of the fifth metacarpal bone, and then passing nsversely outwards beneath the extensor tendons anastomoses with posterior carpal branch of the radial artery, so as to form the *posterior pal arch*. From this arch are derived the *second* and *third dorsal rosseous arteries*, which descend over the spaces between the third l fourth and the fourth and fifth metacarpal bones, and are reinforced the upper ends of those spaces by the junction of the superior perating branches of the deep palmar arch.

5. The **anterior ulnar carpal** branch is a very small artery, which s on the anterior surface of the carpus beneath the flexor profundus, stomoses with a similar offset from the radial artery, and supplies the pal bones and articulations.

**arieties.**—*Origin.*—In the whole number of cases observed by R. Quain, the ar artery was found to deviate from its usual mode of origin, nearly in the portion of one in thirteen. The brachial artery was, more frequently than the llary, the source from which it sprang ; and the lower part of the brachial re frequently than the upper. In one case of high origin of the ulnar artery vessel was connected with the brachial opposite the elbow-joint by means of a transverse branch (Gruber, Reich. Arch., 1871). See, on this subject, the remarks on the varieties of the axillary and brachial arteries.

Fig. 255.

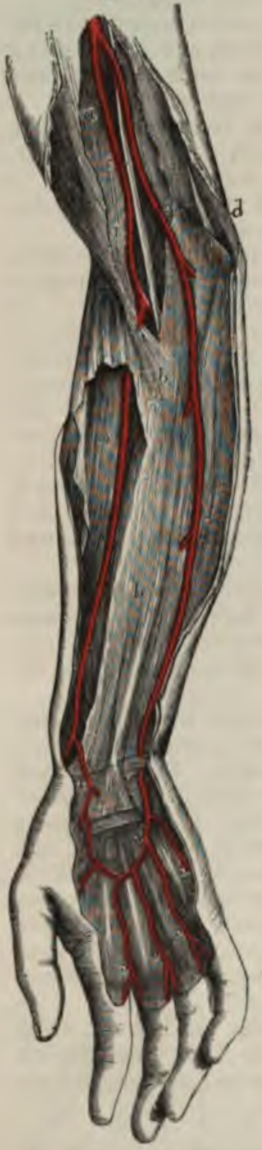


Fig. 255.—High origin and superficial course of the ulnar artery (from R. Quain, and from a preparation in Allen Thomson's collection). ¼

*a*, biceps muscle covered by the deep fascia; *b*, *b*, fascia of the forearm, which has been opened in a considerable extent to show the radial artery subjacent to it; *c*, median nerve; *d*, ulnar nerve; 1, on the biceps muscle, points to the brachial artery after having given off the ulnar artery higher up, and dividing at 1′, into the radial artery and a deep vessel corresponding to the interosseous and a part of the normal ulnar; 2, on the supinator longus muscle, points to the radial artery; 3, 3, artery which is given off by the brachial in the arm, and which descending upon the fascia takes the place of the ulnar at the wrist; 3′, the same continued into the superficial palmar arch, giving off digital branches in the usual manner, and joined by 4, the superficial volar branch of the radial; 5, 5, digital branches.

*Course.*—The position of the ulnar artery in the forearm is more frequently altered than that of the radial.

In cases of high origin, it almost invariably descends over the muscles arising from the inner condyle of the humerus, only one exception to this rule having been met with by R. Quain (pl. 36, fig. 2). In one instance the ulnar artery taking this course divided just below the elbow into a superficial and deep branch (Gruber, *loc. cit.*).

Most commonly in such cases it is covered by the fascia of the forearm; but instances also occur in which the artery rests on the fascia, and either continues in that position or again sinks beneath the fascia lower down, while the vessel thus disposed is distributed below after the manner of the normal ulnar artery. The vessel from which the high ulnar separates is afterwards divided into the radial artery and the interosseous; it appears therefore probable that the abnormal arrangement results from early obstruction of the ulnar artery below the origin of the interosseous, and the development of a superficial vas aberrans, which unites the portion of vessel below the obstruction with the axillary or brachial trunk. The interosseous artery in such cases of abnormality thus comprises not only the ordinary interosseous branch, but likewise the portion of ulnar artery above the obstruction; and, in accordance with this view, we find that the recurrent branches are derived from it.

The ulnar artery has been seen occasionally taking a superficial course when arising in the usual situation, and in these cases also the recurrent and interosseous arteries are given off by the radial trunk.

As to *size*, the ulnar artery presents some varieties which are generally accompanied by deviations of an opposite and compensating character in the radial artery; but as these influence the extent of the distribution of the ulnar artery in the hand they will be noticed in connection with the varieties of the vessels of that part.

*Branches.*—The *anterior* and *posterior ulnar recurrent* branches frequently arise by a common trunk. One or both have been seen to arise from the brachial artery.

The *anterior* and *posterior interosseous arteries* are occasionally given separately from the ulnar. The common interosseous trunk has been found to arise above its ordinary situation, taking origin from the brachial, and even (but more rarely) from the axillary artery. The anterior interosseous artery has been seen of large size, reinforcing the radial or, more rarely, the ulnar artery by means of a transversely directed branch joining the main trunk at the wrist (enlargement of an anterior carpal artery); or its posterior branch has been seen joining the radial on the back of the hand. More frequently it gives off a large median artery.

*Median artery.*—The branch accompanying the median nerve is sometimes much enlarged, and in such cases may be regarded as a reinforcing vessel. It is generally a branch of the anterior interosseous, but sometimes of the ulnar; and more rarely a median branch has been met with descending from the brachial or axillary artery. Generally accompanying the median nerve beneath the annular ligament, occasionally however passing over the front of the ligament, it enters the palm of the hand and there ends, most frequently by joining the superficial palmar arch, sometimes by forming digital branches, and in other cases by joining digital branches given from other sources (figs. 251, 260).

### SUPERFICIAL PALMAR ARCH (IV).

The superficial palmar arch is the continuation of the ulnar artery in the hand. As it passes over the anterior annular ligament the ulnar artery gives off its deep branch, and a little below that band it turns outwards across the palm of the hand towards the middle of the muscles of the thumb. In this course the vessel describes a curve, having its convexity directed towards the fingers, and extending downwards somewhat lower than a line on a level with the metacarpo-phalangeal articulation of the thumb. The arch is sometimes completed on the outer side by inosculating with the superficial volar branch of the radial artery, and in many cases it is connected also, by a small branch, with the radialis indicis or princeps pollicis artery at the lower border of the adductor pollicis muscle.

The superficial palmar arch rests at its commencement on the annular ligament of the wrist, and slightly on the short muscles of the little finger; then on the tendons of the superficial flexor of the fingers, and the divisions of the median and ulnar nerves, the latter nerve accompanying the vessel for a short distance. It is covered towards the ulnar border of the hand by the palmaris brevis, and afterwards by the palmar fascia and the integument.

BRANCHES.—The superficial palmar arch gives off small twigs to the superficial muscles and integument of the palm, and the following larger branches to the fingers:—

The **digital arteries** (v), usually four in number, proceed downwards from the convexity of the palmar arch to supply both sides of the three inner fingers, and the ulnar side of the fore finger. The *first digital* branch (often derived from the deep arch) inclines inwards to the ulnar border of the hand, and, after giving minute offsets to the muscles of the little finger, runs along the inner margin of its phalanges. The *second* runs along the fourth intermetacarpal space, and at the root of the fingers divides into two *collateral branches,* which proceed along the contiguous borders of the ring and little fingers. The *third* is similarly distributed to the ring and middle fingers; and the *fourth* to the middle and index fingers. The thumb and the radial side of the index finger are supplied from the radial artery.

Fig. 256.

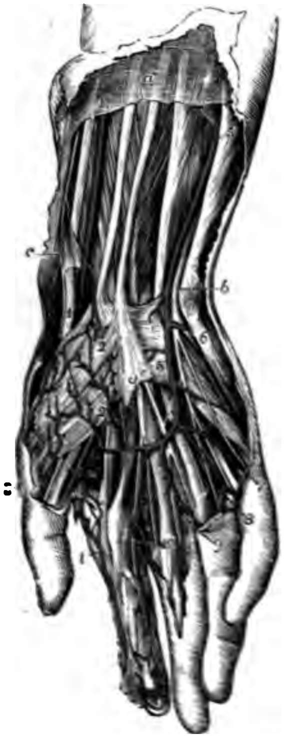


Fig. 256.—Superficial dissection of the lower part of the forearm and the hand, showing the radial and ulnar arteries, the superficial palmar arch, and the accompanying nerves (from R. Quain). ½

*a*, placed on the deep fascia of the forearm, between the tendons of the palmaris longus and flexor carpi radialis muscles; *b*, points by a line crossing the pisiform bone to the ulnar nerve; *c*, points to the styloid process of the radius and twigs of the radial nerve; 1, radial artery lying on the flexor longus pollicis; 1′, the same passing beneath the tendons of the extensor ossis metacarpi and ext. primi internodii pollicis; 2, superficial volar branch, piercing the short muscles of the thumb and emerging below to join the superficial palmar arch; 3, external branch of the princeps pollicis; 4, radialis indicis; a branch from the superficial arch is seen joining the internal branch of the princeps pollicis; 5, ulnar artery lying upon the flexor profundus digitorum; 5′, the same descending on the anterior annular ligament to form the superficial palmar arch; 6, deep branch of the ulnar artery passing between the abductor and flexor minimi digiti to join the deep arch, accompanied by the deep branch of the ulnar nerve; 7, 8, 9, 10, four digital arteries from the superficial arch; 7, and 8, are accompanied by the digital branches of the ulnar nerve, and 3, 4, 9, and 10, by branches of the median nerve.

The digital arteries descend in the intervals between the flexor tendons, resting upon the digital nerves and lumbricales muscles, as far as the clefts of the fingers, where they are joined by the palmar interosseous arteries from the deep arch, and by inferior perforating arteries from the back of the hand. On the sides of the fingers, each collateral artery lies beneath the corresponding nerve, and gives branches which supply the sheaths of the tendons and the joints, some of them anastomosing across the front of the bones with similar branches from the opposite side. At about the middle of the last phalanx, the two arteries of each finger converge and form an arch, from which numerous branches proceed to supply the skin and subcutaneous tissue of the tip of the finger. Other offsets pass to the structures on the back of the second and third phalanges, and form a close plexus beneath the matrix of the nail.

The varieties observed in the branches of the superficial palmar arch will be noticed after the description of the deep arteries of the hand.

The deep branch of the ulnar artery arises at the commencement of the superficial palmar arch, immediately below the pisiform bone; passing deeply into the palm between the abductor and short flexor muscles of the little finger, it inosculates with the termination of the radial artery and so completes the deep palmar arch.

## RADIAL ARTERY (IV).

The radial artery appears by its direction to be the continuation of the brachial, although it does not equal the ulnar in size. It extends along the front of the forearm as far as the lower end of the radius, below which it turns round the outer border of the wrist, and descends to the upper end of the space between the metacarpal bones of the thumb and forefinger: there it passes forwards into the palm of the hand, supplies digital branches to the thumb and index finger, and terminates in the deep palmar arch. In consequence of the changes in its direction, the course, connections and branches of the radial artery may be separately described in the forearm, at the wrist and in the hand.

In the forearm.—The radial artery, commencing at the point of bifurcation of the brachial opposite the neck of the radius, descends with a nearly straight course, along the outer part of the front of the forearm, to the styloid process of the radius. Its position is indicated by a line drawn from the middle of the bend of the elbow to the narrow interval between the scaphoid bone and the tendons of the extensors of the thumb, which can be readily felt on the outer border of the wrist.

The radial artery is nearer to the surface than the ulnar; it is covered in its upper half by the fleshy part of the supinator longus muscle, which must be drawn aside in order to bring the vessel into view; in its lower half only by the integument and fascia. At first it is in contact with the tendon of the biceps, and is supported by the fatty tissue contained in the hollow in the front of the elbow, which separates it from the short supinator muscle. It then rests in succession on the insertion of the pronator teres, the thin radial origin of the flexor sublimis, the flexor longus pollicis, the pronator quadratus, and the lower end of the radius. It is at this last point that the pulse is usually felt during life. To the inner side of this vessel lie the pronator teres in the upper part of its course, and the flexor carpi radialis in the remainder; and on the outer side, in its whole course along the forearm, is the supinator longus muscle.

*Relation to veins.*—The artery is accompanied by *venæ comites*, which have the usual arrangement of those veins.

*Relation to nerves.*—The *radial nerve* is near the artery, on its outer side, in the middle third of its course. At the elbow this nerve is separated from the artery by a considerable interval; and towards the lower end of the forearm it turns backwards beneath the tendon of the supinator longus, to reach the dorsal aspect of the limb, and thus loses all connection with the artery. Some filaments of the *external cutaneous nerve* pierce the fascia to reach the lower part of the artery, which they accompany to the back of the carpus.

Branches.—In the forearm the radial artery gives many small *muscular* offsets to the surrounding muscles and the following named branches, viz.:—

1. The **radial recurrent artery**, which varies much in size, arches upwards from the radial soon after its origin, running between the branches of the musculo-spiral nerve. It lies at first on the supinator brevis, and then on the brachialis anticus, being covered by the supinator longus. In the interval between the last two muscles, it anastomoses with the anterior terminal branch of the superior profunda.

From the lower or convex side of this artery are given off several branches; one or more, of considerable size, to the supinator and radial extensor muscles, and some beneath the latter to anastomose with the posterior interosseous recurrent. It also supplies the supinator brevis, and brachialis anticus in part.

Fig. 257.

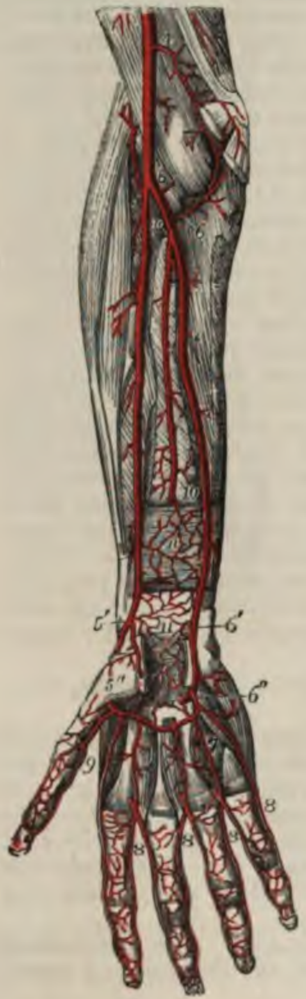


Fig. 257.—DEEP ANTERIOR VIEW OF THE ARTERIES OF THE FOREARM AND HAND (from Tiedemann). ¼

For the full description of this figure see p. 418. The following numbers refer to the radial artery and its branches: 5, upper part of the radial artery and radial recurrent; 5′, lower part of the radial artery, giving off the anterior carpal and superficial volar branches; 5″, the radial artery, emerging from between the heads of the abductor indicis muscle and forming the deep palmar arch; 9, placed between the princeps pollicis and radialis indicis branches of the radial artery.

**2.** The **anterior radial carpal** is a small branch which arises near the lower border of the pronator quadratus muscle, and runs inwards in front of the wrist to anastomose with a similar branch of the ulnar artery. The arch thus formed (*anterior carpal arch*) is joined above by communicating offsets from the anterior interosseous artery and below by the recurrent branches of the deep palmar arch, thus giving rise to a network over the front of the wrist, from which twigs are supplied to the carpal bones and articulations.

**3.** The **superficial volar artery,** arising from the radial near the place where it leaves the front of the forearm, passes onwards into the hand. In size it is variable; in most instances it is very small, and ends in the muscles of the thumb; but in others it attains considerable size, and, crossing these muscles, terminates by inosculating with the radial extremity of the superficial palmar arch, which it thus completes.

AT THE WRIST.—Below the styloid process of the radius, the radial artery turns backwards, passing beneath the tendons of the extensors of the metacarpal bone and first phalanx of the thumb, and resting upon the external lateral ligament of the wrist-joint. It then runs downwards for a short distance over the scaphoid bone and trapezium, being crossed by the tendon of the extensor of the second phalanx of the thumb, and reaches the upper end of the space between the first and second meta-

Fig. 258.

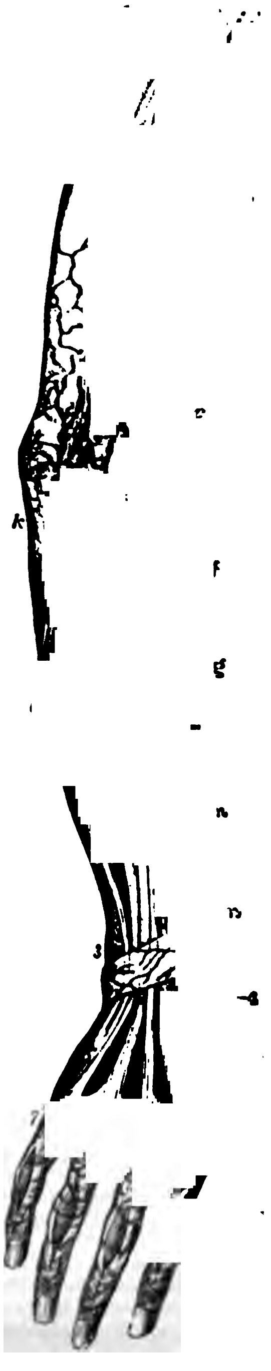


Fig. 258.—Arteries of the outer and back part of the arm and hand, superficial view (from Tiedemann). ¼

*a*, deltoid muscle ; *b*, outer head of triceps ; *c*, biceps ; *d*, brachialis anticus ; *e*, supinator longus ; *f*, extensor carpi radialis longior ; *g*, brevior ; *h*, extensor communis digitorum and extensor minimi digiti ; *i*, extensor carpi ulnaris ; *k*, anconeus ; *l*, flexor carpi ulnaris ; *m*, extensor ossis metacarpi pollicis ; *n*, extensor primi internodii pollicis ; *o*, extensor secundi internodii pollicis ; 1, 1, cutaneous and posterior terminal branches of the superior profunda artery, the latter descending to anastomose with the branches of the interosseous and radial recurrent arteries ; 2, above the posterior annular ligament, points to the posterior branch of the anterior interosseous artery ; 3, posterior carpal branch of the ulnar artery ; 4, radial artery, taking its course between the external lateral ligament of the wrist-joint and the tendons of the extensor muscles before passing near 5, between the two heads of the abductor indicis ; beneath the extensor tendons is seen the posterior carpal arch, giving in this case the three dorsal interosseous arteries ; 6, the inner dorsal artery of the thumb ; 7, the outer dorsal artery of the index finger ; 7′, the metacarpal branch of the ulnar artery and between 7, and 7′, the remaining dorsal digital arteries, formed by the bifurcation of the dorsal interosseous arteries.

carpal bones, where it turns forwards into the palm of the hand, by passing between the heads of the first dorsal interosseous muscle.

As it turns round below the end of the radius the artery is deeply seated, but afterwards it comes nearer to the surface. It is accompanied by two veins and by some filaments of the external cutaneous nerve, and is crossed by subcutaneous veins and by branches of the radial nerve.

Branches.—**1.** The **posterior radial carpal** is a small but constant branch. It arises beneath the extensor tendons of the thumb, and running inwards on the back of the carpus anastomoses with the posterior ulnar carpal branch, completing the *posterior carpal arch,* from which the dorsal interosseous arteries of the third and fourth spaces spring. It anastomoses, also, with the terminal branch of the anterior interosseous of the forearm.

**2.** The **first dorsal interosseous artery**, arising beneath the extensor tendons of the thumb, frequently in common with the posterior carpal branch, passes to the interval between the second and third metacarpal bones, communicates with the first superior perforating branch of the deep palmar arch, and descends on the second dorsal interosseous muscle to the level of the metacarpo-phalangeal articulations. It here sends forwards a slender *inferior perforating* branch to join the corresponding palmar digital artery, and ends by dividing into two *dorsal digital* branches which ramify on the adjacent margins of the index and middle fingers, as far as the base of the second phalanx, and anastomose on the sides of the fingers with the palmar collateral arteries.

The second and third dorsal interosseous arteries, springing from the posterior carpal arch, are distributed in a similar manner in the third and fourth interdigital spaces, but their inferior perforating branches are often wanting.

**3.** The **dorsal arteries of the thumb,** two small branches, arising separately or together opposite the base of the metacarpal bone, run upon the dorsal aspect of the thumb-bones, one at the radial, the other at the ulnar border.

**4.** The **dorsal artery of the index finger**, a very small branch, arises below the preceding, and, sending branches to the abductor indicis, runs along the radial side of the back of the index finger.

IN THE HAND.—The radial artery, entering the palm between the heads of the abductor indicis muscle, immediately gives off, under cover of the deep part of the flexor brevis pollicis, the large artery of the thumb and the radial branch of the index finger, and turns inwards to form the deep palmar arch by inosculating with the deep branch of the ulnar artery.

The **large artery of the thumb** (*art. princeps pollicis*) passes downwards in front of the abductor indicis, between the metacarpal bone of the thumb and the muscles covering it, to the space between the heads of the flexor brevis pollicis. At that point, and beneath the tendon of the long flexor, it divides into two collateral branches, which course along the borders of the phalanges, on their palmar aspect, and unite in front of the last phalanx, to form an arch similar in arrangement to that on the other fingers.

The **radial branch of the index finger** (*art. radialis indicis*) descends between the abductor indicis and adductor pollicis muscles, and continues along the radial border of the index finger, forming its radial collateral branch, and anastomosing in the usual manner on the last phalanx with the ulnar collateral branch derived from the superficial palmar arch. This artery sometimes arises by a common trunk with the foregoing, or more frequently is united with the inner collateral artery of the thumb.

**Varieties.**—*Origin.*—In the observations of Richard Quain, the radial artery was found to arise higher up than usual in nearly one case in eight. Its origin was much more frequently from the axillary, or from the upper part of the brachial, than from the lower part of the latter artery. Low origin of the radial artery is much less frequent (see p. 413), but it has been found arising below the upper third of the forearm (Tiedemann, tab. 47, fig. 3).

*Course.*—The radial artery more rarely deviates from its usual position along the forearm than the ulnar. It has been found lying upon the semilunar fascia of the biceps, and over the aponeurosis of the forearm instead of beneath those structures. It occasionally turns backwards over, instead of beneath, the tendons of the extensor muscles of the thumb; and in rarer cases it has been seen passing backwards, over the supinator longus, above the middle of the forearm, and descending across the thumb-muscles to the wrist. In cases of low origin the radial artery passes beneath the pronator teres and the radial origin of the flexor sublimis digitorum to its usual position between the tendons of the supinator longus and flexor carpi radialis, and in two or three of these cases it has been seen joined by a vas aberrans as it makes its appearance superficially (R. Quain, pl. 35, fig. 4, G. D. T.). As has been previously stated (p. 414), the vasa aberrantia occasionally derived from the brachial or axillary artery commonly end by joining the radial, or one of its branches.

*Size.*—The radial artery is sometimes much smaller than usual, and it has been seen terminating in the carpal and superficial volar offsets, or in muscular offsets at a variable level in the forearm. A few instances of absence of the radial artery are also recorded, the brachial artery being continued directly into the ulnar-interosseous trunk, and giving off only a radial recurrent branch at the usual place of division. In these cases the deficiency is generally supplied by the ulnar artery in the hand, or by a large median artery, more rarely by a branch of the anterior interosseous directed outwards in front of the wrist, or joining the diminished radial trunk at the back of the hand (p. 421).

*Branches.*—The *radial recurrent* is sometimes very large, or it may be replaced by several separate branches. One considerable branch occasionally passes backwards on the surface of the supinator brevis muscle, and turns upwards behind the outer condyle of the humerus, replacing the posterior interosseous recurrent artery. When the radial itself arises high up, the recurrent artery usually comes from the residual brachial trunk, or sometimes from the ulnar artery, or more rarely from the interosseous. When given from the brachial trunk, the radial recurrent has been found crossing beneath the tendon of the biceps.

The *superficial volar* branch is sometimes enlarged, and furnishes one or two digital branches (generally to the thumb and index finger), and along with this the communication with the superficial arch may be absent. This branch occasionally arises much higher than usual, and in a few cases the radial artery has been found dividing in the upper part of the forearm into two branches of nearly equal size, the one of which descends into the palm of the hand as the superficial volar artery, giving off also the carpal and dorsal digital branches, while the other passes backwards at a variable level, over the extensor tendons, in the manner described above.

The *carpal* and *dorsal interosseous* branches of the radial are sometimes very small, their place being supplied by the perforating offset of the anterior interosseous, apparently by an enlargement of the ordinary anastomosis between them.

The *first dorsal interosseous* branch is not unfrequently much enlarged, and furnishes the collateral digital arteries to the index and middle fingers. The *dorsal artery of the index finger* may similarly, though more rarely, supply one or both of the collateral arteries of the adjacent sides of the thumb and index finger.

## DEEP PALMAR ARCH (V).

The deep palmar arch, the continuation of the radial artery, commences at the upper end of the first interosseous space, extends transversely across the palm towards the fifth metacarpal bone, and is completed by the deep branch of the ulnar artery. The convexity of the arch thus formed is directed downwards. It rests on the interosseous muscles and on the metacarpal bones immediately below their carpal extremities, and is covered by the flexor brevis pollicis, the flexor tendons of the fingers, and the opponens and flexor brevis minimi digiti. It is nearer to the carpus than the superficial arch, and differs from it in retaining its size almost undiminished. It is accompanied for some distance by the deep branch of the ulnar nerve, which runs from the inner end of the arch outwards.

BRANCHES.—**1.** The **recurrent** branches ascend from the upper concave side of the arch, and anastomose with the branches of the anterior carpal arch.

**2.** The **superior perforating** branches, three in number, frequently arise in common with the following branches; they pass backwards through the upper extremities of the inner three interosseous spaces to inosculate with the dorsal interosseous arteries.

**3.** The **palmar interosseous arteries,** usually three in number, but very liable to variation, lie in front of the interosseous spaces, supply the muscles there, and inosculate at the clefts of the fingers with the digital branches from the superficial arch. There is generally also a communicating branch passing from the innermost interosseous artery, or from the deep arch itself, to the digital artery of the inner side of the little finger.

Fig. 259.

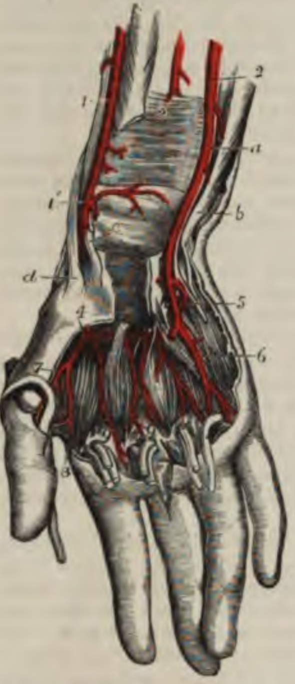


Fig. 259.—Deep arteries of the wrist and palm (from R. Quain). $\frac{1}{3}$

The anterior annular ligament of the wrist has been divided; the lower parts of the common flexors and flexor of the thumb have been removed, and portions of these tendons are turned down upon the fingers with parts of the lumbricales muscles; the superficial palmar arch is removed, and the interosseous muscles are exposed: *a*, ulnar nerve; *b*, tendon of the flexor carpi ulnaris muscle; *c*, tendon of the flexor carpi radialis; *d*, tendon of the extensor ossis metacarpi pollicis; 1, radial artery; 1', its lower part giving off the anterior carpal and superficial volar branches, the latter cut short; 2, ulnar artery; 3, anterior interosseous artery, passing behind the pronator quadratus muscle; 4, radial artery, appearing deeply in the palm between the first and second metacarpal bones and passing into the deep palmar arch; 5, deep branch of the ulnar artery, dipping between the abductor and flexor brevis minimi digiti to join the deep arch, and accompanied by the deep branch of the ulnar nerve; 6, a digital artery, rising from the first part of the superficial palmar arch; 7, princeps pollicis, and 8, radialis indicis arteries; 9, 9, 9, interosseous branches of the deep palmar arch, proceeding down on the interosseous muscles to join the palmar digital arteries from the superficial arch.

It is by an enlargement of these small vessels that the deep palmar arch sometimes supplies the corresponding digital arteries when those derived from the superficial arch are small or absent.

**Varieties of the arteries of the hand.**—The arteries of the hand frequently vary from their usual mode of distribution.

(*a*) By far the larger number of deviations consist of a deficiency in either the radial or ulnar system of arteries, accompanied by a corresponding increase in the other; and it may be observed that the defect is much more commonly on the part of the superficial, and the increase on the part of the deep set.

(*b*) In the second and smaller class of variations a deficiency in one or other of the two systems is supplied, either by the enlargement of branches which descend in front of the limb, as the superficial volar (from the radial), or the median artery (from the anterior interosseous, as shown in fig. 260), or by the enlargement of an interosseous branch (from the radial) on the back of the hand.

In illustration of these general remarks, the following modes of arrangement of the vessels may be mentioned:—

In the greater number of cases the superficial palmar arch is diminished, and gives off fewer digital branches than usual. Generally only one branch is wanting, viz., that which supplies the adjacent sides of the fore and middle fingers; but sometimes two or three branches are absent, or even all four, as when the ulnar artery, after giving branches to the short muscles of the little finger, ends in the deep palmar arch. In the last-mentioned case, which is rare, it is obvious that the superficial arch is altogether wanting.

Fig 260.

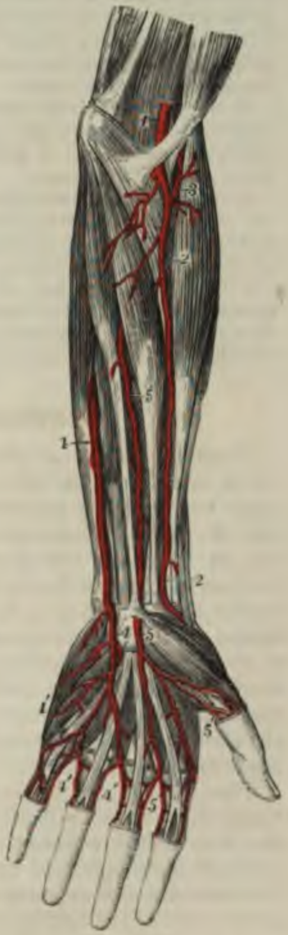


Fig. 260.—An enlarged median artery replacing the radial and ulnar in the supply of palmar arteries to half the digits (from Tiedemann). $\frac{1}{4}$

1, lower part of the brachial artery; 2, radial artery, not giving any superficial volar branch; 3, recurrent radial; 4, ulnar artery, passing over the wrist and supplying at 4′, 4′, 4′, digital arteries to half the hand; 5, the enlarged median artery passing in front of the annular ligament of the wrist, and supplying 5′, 5′, digital branches to the outer half of the hand.

These various deficiencies in the superficial palmar arch and its branches are usually compensated for by an enlargement of the deep arch, the palmar interosseous branches of which, being increased in size, divide at the clefts of the fingers, and form such collateral digital branches as are not derived from the usual source. But a defective superficial arch may, as before mentioned, be reinforced from other vessels, viz., from the superficial volar, from an enlarged median artery, or from a large dorsal interosseous branch.

It sometimes, but less frequently happens, that the deep system of vessels is deficient; in which case the superficial arch may supply all the digital arteries to the thumb and fingers, or one or more of these may be derived from the superficial volar, the median, or a dorsal interosseous artery.

The superficial palmar arch has occasionally been seen double, the superficial part of the ulnar artery and the superficial volar branch of the radial being each divided into two communicating branches. Two of the digital arteries frequently arise by a common trunk.

### SURGICAL ANATOMY OF THE ULNAR AND RADIAL ARTERIES.

In the upper third of the forearm, the depth at which the *ulnar artery* is placed beneath the muscles and the origin of the large interosseous branch prevent the application of a ligature to this part of the vessel.

In the middle third, the artery may be tied as it approaches the ulnar nerve. An incision is made along a line drawn from the internal condyle of the humerus to the pisiform bone, and the intermuscular space between the flexor sublimis digitorum and flexor carpi ulnaris opened up, when the ulnar nerve comes into view. The artery, accompanied by its venæ comites, will be found to the outer side of the nerve, a little way removed from it, and under cover of the flexor sublimis digitorum, if the spot selected be above the middle of the forearm.

Near the wrist, the artery is readily exposed by an incision along the outer border of the flexor carpi ulnaris tendon. After drawing inwards this tendon, a deep layer of fascia is seen covering the vessels, and on dividing this the artery is laid bare with the nerve to its inner side.

The *radial artery* may be ligatured in any part of its extent in the forearm by means of an incision carried through the skin and fascia in the course of the vessel, *i. e.*, along a line from the centre of the bend of the elbow to the fore part of the styloid process of the radius. In the upper half of the forearm, the fleshy belly of the supinator longus will have to be drawn outwards; in the lower half, the artery lies close to the outer side of the tendon of the flexor carpi radialis which forms a guide to the vessel.

At the wrist the radial artery may also be readily secured, the incision being made midway between the tendons of the extensor ossis metacarpi and second internodii pollicis. It is generally preferable, however, to tie the artery at the lower part of the forearm.

*Collateral circulation.*—The communications between the branches of the ulnar and radial arteries, about the wrist and in the palm, are so numerous and free that the circulation in the hand is carried on without difficulty after occlusion of either of the main trunks.

It is important to bear in mind, in connection with wounds of the palmar arteries, the possibility of blood being conveyed to the hand by other channels than the ulnar and radial trunks, viz., by a large median artery, or a terminal branch of the anterior interosseous.

## DESCENDING THORACIC AORTA.

From the point at which its arch is considered to terminate—the lower margin of the fifth dorsal vertebra, the aorta descends along the spine to the fourth lumbar vertebra, where it divides into the common iliac arteries. The direction of this part of the vessel is not vertical, for, as it follows the bend of the spine, upon which it rests, it is necessarily concave forwards in the dorsal region, and convex forwards in the lumbar. Again, as its commencement is on the left side of the bodies of the vertebræ, and its termination nearly in the middle line, there is a general inclination inwards in its whole length, but more marked in the upper half. Within the thorax, where the offsets are small, the aorta diminishes only slightly in size (from 23 to 21 mm.); in the abdomen the diminution is considerable (from 21 to 17 mm.), in consequence of large branches being furnished to the viscera of that cavity.

That part of the descending aorta which is situated in the thorax is called the *descending thoracic aorta;* it extends from the lower border of the fifth dorsal vertebra on the left side, to the opening between the crura of the diaphragm in front of the last dorsal vertebra. It lies in the posterior mediastinum, resting against the spine and covered in front by the root of the left lung and the pericardium; on the left side it is in contact with the corresponding pleura and lung; and close to it on the right side are the azygos vein, the thoracic duct, and the œsophagus. The œsophagus, however, towards the lower part of the thorax, is in front of the artery, and near the diaphragm gets somewhat to the left side. The left or small azygos vein lies behind the descending thoracic aorta.

The BRANCHES derived from the descending thoracic aorta are numerous, but small. They are distributed to the walls of the thorax, and to the viscera contained within it—the parietal branches being the larger and more numerous..

A. Branches to the viscera :—

The **pericardial** branches are some very small and irregular vessels which pass forwards and ramify on the pericardium.

The **bronchial arteries** are the nutrient arteries of the substance of the lung, and they supply also the bronchial glands, and in part the pericardium and œsophagus. These vessels vary frequently in number, and in their mode of origin. On the right side there is usually one bronchial artery which arises from the first aortic intercostal artery, or by a common trunk with the upper left bronchial artery from the descending thoracic aorta; on the left side there are generally two arteries, both of which arise from the descending thoracic aorta, one near the commencement of that trunk, and the other, named *inferior bronchial,* lower down. Each artery is directed to the back part of the corresponding bronchus, along which it runs, dividing and subdividing with the successive bronchial ramifications in the substance of the lung.

**Varieties.**—The place of origin of the bronchial arteries is liable to much variation. The artery of the right side has been found to arise singly from the aorta, from the internal mammary, or from the inferior thyroid. The bronchial arteries of the two sides have been seen to arise by a common trunk from the subclavian (Haller). Two common trunks, each furnishing a branch to the right and left lungs, have been observed in a single case to descend into the thorax, after arising, one from the internal mammary, and the other from the superior intercostal artery (R. Quain, pl. 26, fig. 5). In some cases they arise from the under surface of the arch, instead of from the descending thoracic aorta. Instances also occur of two distinct bronchial arteries for each lung.

The **œsophageal arteries** are variable in size and number. There are usually four or five, which arise from the fore part or right side of the aorta, and run downwards upon the œsophagus, supplying its coats. Their lower branches anastomose with the ascending offsets of the coronary artery of the stomach and with the phrenic arteries, while their upper branches communicate with those of the inferior thyroid artery.

**Posterior mediastinal** branches, small and irregular, supply the glands, areolar tissue, and other structures in the posterior mediastinum, as well as the vertebral portion of the diaphragm.

B. Branches to the wall of the thorax :—

The **intercostal arteries (iv)** arise from the posterior part of the aorta, and run outwards upon the bodies of the vertebræ, to reach the intercostal spaces. They are usually nine in number—the upper two spaces being supplied by the superior intercostal branch of the subclavian artery. Owing to the position of the aorta on the left side of the spine, the right aortic intercostals cross over the front of the vertebræ, furnishing small branches to their interior, and are longer than the arteries of the left side. The vessels of both sides pass outwards behind the pleura, and are crossed by the sympathetic nerve: those of the right side also pass behind the œsophagus, the thoracic duct, and the large azygos vein.

In each intercostal space the artery, passing outwards more horizontally than the ribs, crosses the space obliquely, so as to gain the lower border of the upper rib near its angle. It lies upon the deep surface of the external intercostal muscle, and in the back of the space is separated from the pleura only by a thin fascia, but farther outwards it lies between the two layers of intercostal muscles. Extending forwards in the subcostal groove of the upper rib, it finally anastomoses with one of the anterior intercostal branches derived from the internal mammary artery.

Fig. 261.

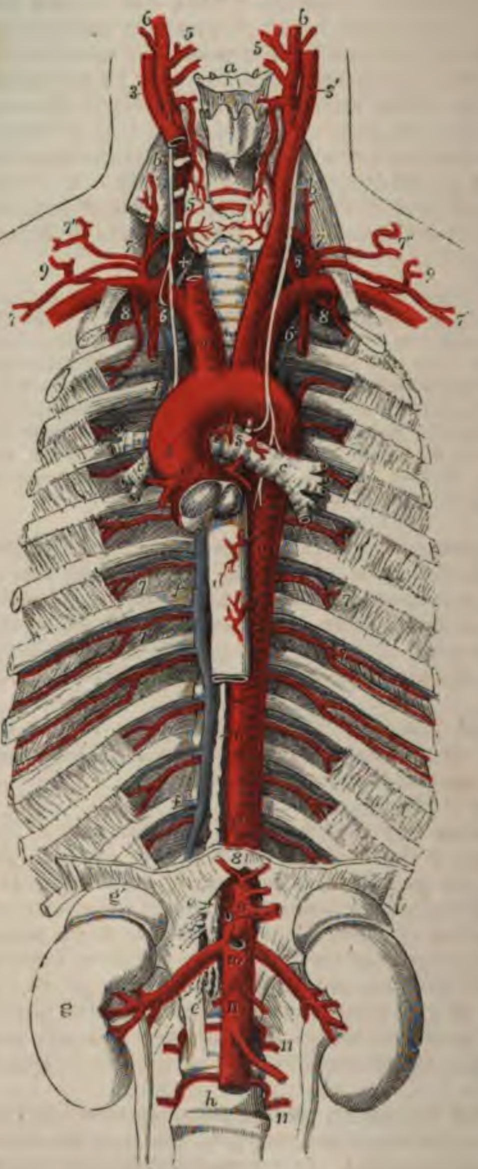


Fig. 261.—THE THORACIC AND GREATER PART OF THE ABDOMINAL AORTA, &c. $\frac{1}{4}$

For the general description of this figure, see p. 354. The following numbers indicate the branches of the aorta; 1, placed between the origins of the right and left coronary arteries; 2, innominate; 3, left carotid; 4, left subclavian; 5, bronchial; 6, 6, œsophageal; 7, 7, intercostal arteries (sixth and seventh); 8, inferior phrenic; 9, cœliac axis; 10, below the superior mesenteric and opposite the origin of the renal arteries; 11, 11, two of the lumbar arteries.

The first of the aortic intercostal arteries has an anastomosis with the superior intercostal artery from the subclavian, and not unfrequently sends upwards a considerable branch, which supplies the second space wholly or in great part. The last two are prolonged into the abdominal wall, where they communicate with the epigastric artery, and with the lumbar branches of the abdominal aorta.

Each intercostal artery is accompanied, as it runs outwards between the ribs, by a corresponding vein, and by an intercostal nerve; the vein being usually above, and the nerve below it.

*Branches.*—(*a*) The *posterior* or *dorsal* branch of each intercostal artery passes backwards to the inner side of the superior costo-transverse ligament, along with the posterior branch of the corresponding nerve; and, having furnished an offset to the spinal canal, reaches the muscles of the back, and divides into an internal and an external branch. The internal branch is directed towards the spinous processes, on or through the multifidus spinæ, and ramifies in the muscles and the skin. The external branch turns outwards under the longissimus dorsi, and is distributed between that muscle and the ilio-costalis; some twigs reach the superficial muscles and the integuments.

The *spinal* branch is distributed partly to the cord and its membranes, and partly to the bones, in the same manner as the spinal branches of the lumbar arteries (p. 447).

(*b*) The *collateral intercostal* branch, long and slender, arises near the angle of the upper rib of the space, inclines downwards, and is continued along the border of the lower rib, to anastomose in front with an anterior intercostal branch of the internal mammary artery. There are thus in each intercostal space two terminal branches of the intercostal artery communicating with the branches of the internal mammary.

Both the main trunk and the collateral branch give offsets to the intercostal muscles and ribs, and small twigs which anastomose beneath the pleura with one another and with branches of the internal mammary and bronchial arteries (see p. 400). Other branches supply the muscles covering the thorax and anastomose with the thoracic branches of the axillary artery, and one accompanies the lateral cutaneous branch of the intercostal nerve to the skin. From the arteries in the third, fourth, and fifth spaces branches are sent to the mammary gland in the female.

**Varieties.**—The number of trunks by which the intercostal arteries arise is subject to much variation: two or even three arteries of the same side, especially the upper ones, sometimes arise by a single stem. One or two of these vessels may be absent on one side, the corresponding spaces being supplied by branches from the neighbouring intercostal arteries.

## ABDOMINAL AORTA.

The aorta, after having passed the diaphragm, is thus named. It commences on the front of the last dorsal vertebra, and terminates below by dividing into the two common iliac arteries. The bifurcation usually takes place about half-way down the body of the fourth lumbar vertebra, a little to the left of the middle line; a point which is nearly on a level with a line drawn from the highest part of one iliac crest to the other, and which corresponds to a spot on the front of the abdomen, slightly below and to the left side of the umbilicus.

The anterior surface of the abdominal aorta is successively in apposition with the pancreas and the splenic vein, the left renal vein, the third portion of the duodenum, and the peritoneum. The vena cava lies along its right side, the right crus of the diaphragm being interposed at the upper part; close to the same side are the thoracic duct and the azygos vein, which are placed between the aorta and the crus of the diaphragm. The aorta is also covered in front by the solar and aortic plexuses of the sympathetic nerve, by numerous lymphatic vessels and glands, and by a layer of dense areolar tissue.

BRANCHES.—The abdominal aorta gives numerous branches, which may be divided into two sets, viz., those which supply the viscera, and those which are distributed to the walls of the abdomen. The former consists of the cœliac artery, the superior mesenteric, the inferior

Fig. 262.

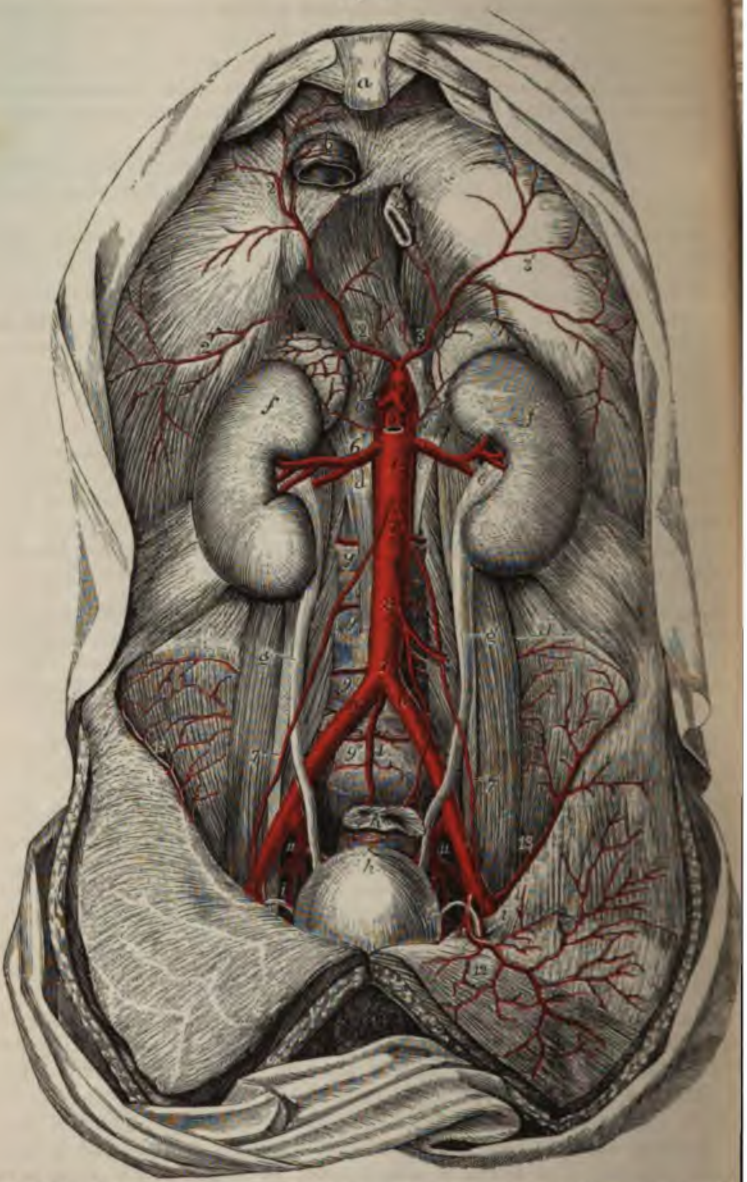


Fig. 262.—The abdominal aorta and its principal branches (from Tiedemann).

*a*, ensiform process; *b*, inferior vena cava, passing through the tendon of the di phragm; *c*, œsophagus, passing through the muscular portion; *d* and *e*, tendinous par of the right and left crura; *f*, *f′*, right and left kidneys with the suprarenal bodies; *g*, *g* ureters; *h*, upper part of the urinary bladder; *i*, *i*, right and left vasa deferentia passi up from the bladder to the internal abdominal rings; *k*, rectum, divided near its upp end; 1, 1, abdominal aorta; 1′, middle sacral artery; 2, 2′ right, 3, 3′, left inferior phre artery, arising by a short common stem from the front of the aorta immediately below the meeting of the crura of the diaphragm ; 4, cœliac axis ; 5, superior mesenteric artery ; 6, 6, renal arteries ; 6′, 6′ suprarenal arteries arising partly from the aorta and partly from the inferior phrenic ; 7, placed on the front of the aorta below the origin of the spermatic arteries ; 7, 7′, placed on the psoas muscles, point to the right and left spermatic arteries as they descend to the internal abdominal rings ; 8, inferior mesenteric artery ; 9, 9, 9, lumbar arteries ; 9′, lowest lumbar artery ; 10, 10, common iliac arteries ; 11, between the external and internal iliac arteries ; 12, left epigastric artery ; 13, circumflex iliac ; 14, branches of the ilio-lumbar.

mesenteric, the suprarenal, the renal, and the spermatic arteries ; while in the latter are included the phrenic, the lumbar, and the middle sacral arteries. The first three of the visceral branches are single arteries.

**Varieties.**—*Place of division.*—In more than three-fourths of a considerable number of cases, the aorta divided either upon the fourth lumbar vertebra, or upon the intervertebral disc below it ; in one case out of nine it was below, and in about one out of eleven above the spot thus indicated : in ten bodies out of every thirteen, the division of the great artery took place within half an inch above or below the level of the iliac crest (R. Quain). An instance of bifurcation immediately below the origin of the right renal artery is recorded by Haller (Disputat. Anatom., t. vi., p. 781), and division opposite the second lumbar vertebra has been observed by Boinet (Arch. gén. de Méd., 1835, vii., 233), Cruveilhier (" Anatomie," 5th Ed., iii., 148), and Eckhard (Zeitsch. f. rat. Med., xxxi., 408).

*Unusual branch.*—Two remarkable cases are recorded of the existence of a large pulmonary branch which arose from the abdominal aorta, close to the cœliac axis, and, after passing upwards through the œsophageal opening in the diaphragm, divided into two branches, which were distributed to the lungs near their bases (see Henle, *op. cit.*, p. 292).

### A.—VISCERAL BRANCHES OF THE ABDOMINAL AORTA.

The **cœliac artery** or **axis** (i) is a short wide vessel, usually not more than half an inch in length, which arises from the front of the aorta close to the margin of the opening in the diaphragm. It is directed nearly horizontally forwards at the upper border of the pancreas, being placed behind the small omentum and close to the left side of the Spigelian lobule of the liver. The two semilunar ganglia of the sympathetic are also contiguous to it, one on each side. The artery divides into three branches, viz., the coronary artery of the stomach, the hepatic, and the splenic, which separate simultaneously from the end of the trunk like radii from an axis.

**Varieties.**—The cœliac axis is occasionally partly covered at its origin by the diaphragm. It may be longer than usual, in which case its branches are not given off together ; or it may be entirely wanting, the coronary, hepatic, and splenic arteries arising separately from the aorta. In some cases the cœliac artery gives off only two branches at its division (the coronary and the splenic), the hepatic being supplied from another source. Rarely, it gives more than three branches to the viscera, the additional vessel being a second coronary, or a separate gastro-duodenal artery. One or both phrenic arteries are frequently derived from this trunk. Cases have been met with in which a connection existed between the cœliac axis and the superior mesenteric artery close to their origin.

A. The **coronary artery of the stomach** (iii-iv), the smallest of the three branches derived from the cœliac axis, runs at first upwards and to the left side, and reaches the cardiac orifice of the stomach. It then turns sharply forwards and downwards, and is continued from left to right along the small curvature of the stomach, distributing branches to both surfaces of that viscus, and finally inosculating with the pyloric branch of the hepatic artery.

Where it first reaches the stomach, this artery sends upwards *œsophageal* branches, which anastomose with the aortic œsophageal arteries. The branches to the stomach, descending on the fore and back part of the organ, anastomose with branches from the arterial arch on the great curvature.

**Varieties.**—The coronary artery of the stomach is sometimes given off directly from the aorta; and is occasionally replaced by two separate vessels. It sometimes furnishes the left or an additional hepatic artery; and according to Hyrtl there is constantly a small branch which ascends to the left end of the transverse fissure of the liver and anastomoses with an offset of the left hepatic artery.

B. The **hepatic artery** (ii) is in the adult intermediate in size between the coronary and splenic arteries, but in the fœtus it is the largest of the three. It is directed at first forwards and to the right, passing over the upper border of the pancreas, and below the foramen of Winslow, to the upper margin of the pyloric orifice of the stomach, where it gives off its gastro-duodenal branch. It then ascends between the layers of the small omentum, and in front of the foramen of Winslow, towards the transverse fissure of the liver; and in this course it lies upon the portal vein, and to the left of the common bile-duct. Near the liver, it ends by dividing into right and left branches, which supply the corresponding lobes of that organ.

*Branches.*—(*a*) The *gastro-duodenal artery* (iv) descends near the pylorus behind the first part of the duodenum, and divides at the lower border of that viscus into a smaller superior pancreatico-duodenal and a larger right gastro-epiploic artery. The *superior pancreatico-duodenal artery* descends along the inner margin of the duodenum, between that and the pancreas, and, after furnishing several branches to both these organs, anastomoses with the inferior pancreatico-duodenal from the superior mesenteric artery. The *right gastro-epiploic artery*, the continuation of the gastro-duodenal, runs from right to left along the great curvature of the stomach, between the layers of the great omentum, and ends by inosculating with the left gastro-epiploic from the splenic artery. It sends branches upwards to both surfaces of the stomach, and long slender vessels downwards to the omentum.

(*b*) The *pyloric artery*, descending from its origin and coming in contact with the stomach at the upper border of the pylorus, extends from right to left along the small curvature, and inosculates with the coronary artery. It is sometimes a branch of the gastro-duodenal.

(*c*) The *right hepatic* branch inclines outwards behind the hepatic and cystic ducts (occasionally in front of the hepatic), giving off the cystic artery as it passes these, and reaches the right end of the transverse fissure, where it divides into two or three branches as it enters the liver substance. The *cystic artery* (vi) turns forwards upon the neck of the gall-bladder, and divides into two smaller branches, of which one ramifies between the coats on the inferior surface, the other between the bladder and the liver.

(*d*) The *left hepatic* branch, smaller than the right, from which it diverges at an acute angle, gives off one or two branches to the Spigelian

Fig. 263.

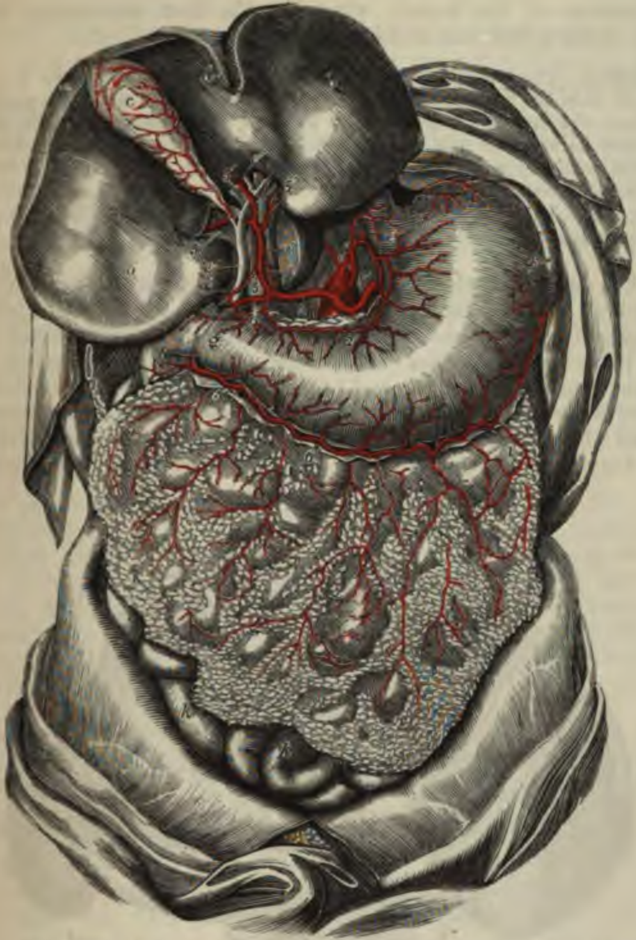


Fig. 263.—THE ARTERIES OF THE STOMACH, LIVER, AND OMENTUM (from Tiedemann). $\frac{1}{4}$

e liver is turned up so as to show its lower surface with the portal fissure, and the
ls and ducts entering it : *a*, right lobe of the liver ; *b*, left lobe ; *c*, gall-bladder ;
epatic ducts ; *c*", common bile-duct ; *d*, umbilical fissure and round ligament ; *e*,
iac orifice of the stomach ; *f*, on the great curvature of the stomach near its cardiac
points to the spleen ; *g*, pylorus ; *h*, duodenum ; *i*, *i*, great omentum ; *k*, *k*, part
e small intestine in the lower part of the abdomen ; 1, upon the trunk of the
minal aorta, below the root of the inferior phrenic arteries, and above the cœliac
; 2, placed on the meeting of the crura of the diaphragm, the coronary artery of the
ach ; 2′, the same artery proceeding round the small curvature of the stomach and
ng by inosculating with the pyloric ; 3, the main hepatic artery, continued at 3′ as
er hepatic artery to the liver ; 4, pyloric artery ; 4′, another pyloric branch ; 5,
k of the portal vein ; 5′, 5′, 5′, its branches in the transverse fissure ; 6, gastro-
enal artery ; 6′, 6′, its continuation as the right gastro-epiploic ; 7, on the left crus
e diaphragm, the splenic artery ; 8, its left gastro-epiploic branch, proceeding round
reat curvature of the stomach to communicate with the right gastro-epiploic artery ;
of these vessels are seen giving long epiploic as well as gastric branches.

lobule, and enters the liver at the left end of the transverse fissure. The ramifications of the hepatic artery in the liver accompany the divisions of the portal vein and hepatic duct.

**Varieties.**—The hepatic artery sometimes arises from the superior mesenteric artery, or from the aorta itself. The left hepatic artery is not unfrequently derived from the coronary artery of the stomach, occasionally from the superior mesenteric, rarely from the splenic. Accessory hepatic arteries are sometimes met with, generally coming from the coronary artery, less frequently from the superior mesenteric, the aorta, the right renal, or the inferior mesenteric. The hepatic artery has been found to furnish a phrenic branch. The cystic artery has been seen arising from the superior mesenteric.

C. The **splenic artery** (**ii**), in the adult the largest branch of the cœliac axis, supplies the spleen, and in part the stomach and pancreas. Waving and often tortuous in its course, it passes along the upper border of the pancreas, and divides near the spleen into several branches, which are distributed to that organ and to the left portion of the stomach.

*Branches.*—(*a*) *Pancreatic* branches, variable in size and number, are given off while the artery is passing along the pancreas, the body and tail of which they supply. One of larger size not unfrequently runs from left

Fig. 264.

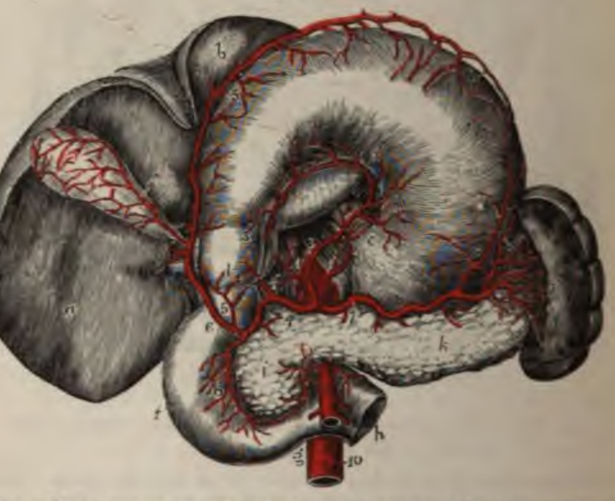


Fig. 264.—THE ARTERIES OF THE STOMACH, DUODENUM, PANCREAS, AND SPLEEN (from Tiedemann). ¼

The stomach and liver are turned upwards; the jejunum is divided at its commencement: *a*, right lobe of the liver; *b*, left lobe; *c*, cardiac orifice of the stomach; *d*, pylorus; *e*, first part, *f*, second part, and *g*, third part of the duodenum; *h*, commencement of the jejunum; *i*, head, and *k*, body of the pancreas; *l*, spleen; 1, 1, right and left inferior phrenic arteries passing from the aorta upon the crura of the diaphragm; 2, placed on the aorta close to the cœliac axis; 3, 3′, coronary artery; 4, common hepatic; 4′, 4′, proper hepatic artery and its right branch; 4″, cystic artery; 5, 5, right gastro-epiploic, and 6, superior pancreatico-duodenal, the two divisions of the gastro-duodenal; 7, splenic artery; 7′, splenic branches; 7″, one of the vasa brevia to the stomach; 8, 8, left gastro-epiploic artery, uniting with the right on the great curvature of the stomach; 9, trunk of the superior mesenteric artery, giving off the inferior pancreatico-duodenal; 10, inferior mesenteric.

right in the direction of the pancreatic duct, and is called *arteria pan-eatica magna.*

(*b*) The *splenic* branches are the proper terminal branches of the tery; they are five or six, or even more, in number, and vary in length nd size; they enter the spleen by the hilus on its concave surface, nd ramify within that organ.

(*c*) The *short gastric* branches (*vasa brevia*), from four to six in number, re directed forwards and to the right, some issuing from the trunk f the splenic artery, others from its terminal branches: they reach the eft extremity of the stomach, where they divide and spread out between ts coats, communicating with the coronary and left gastro-epiploic rteries.

(*d*) The left *gastro-epiploic artery* runs from left to right along the great curvature of the stomach, supplying branches to both surfaces of he stomach and to the omentum on the left side, and inosculates with he right gastro-epiploic branch from the hepatic artery.

**Varieties.**—These are not frequent. The splenic artery has been seen to give f the left hepatic artery, the middle colic artery, and in one case, together with e last, the inferior mesenteric artery.

The **superior mesenteric artery** (i) supplies the whole of the mall intestine beyond the duodenum, and half of the large intestine. It rises from the fore part of the aorta, a little below the cœliac axis, and nder cover of the pancreas and splenic vein. Emerging below the ancreas, it crosses the left end of the third part of the duodenum, and lescends between the layers of the mesentery. Much diminished in size wing to the large number of its branches, it inclines below towards the ight iliac fossa, and ends near the junction of the ileum with the large ntestine by inosculating with its own ileo-colic branch.

*Branches.*—(*a*) The *inferior pancreatico-duodenal*, generally arising om the first intestinal branch and directed transversely to the right ehind the main trunk, runs along the concave border of the duodenum, nd joins with the superior pancreatico-duodenal artery.

(*b*) The *intestinal* branches, supplying the jejunum and ileum, spring om the convex or left side of the vessel. They are usually twelve or ore in number, and are all included between the layers of the mesenry. They run parallel to one another for some distance, and then ivide into two branches, each of which forms an arch with the neighouring branch. From the first set of arches other branches issue, hich divide and communicate in the same way, until finally, after rming from three to five such tiers of arches, the smaller as they are earer to the intestine, the ultimate divisions proceed directly to the ntestine, spreading upon both sides, and ramifying in its coats. Small ffsets are also furnished to the glands and other structures between the yers of the mesentery.

(*c*) The *colic* branches arise from the right or concave side of the rtery, and are usually three in number.

1. The *ileo-colic artery*, the first in order from below upwards, inclines ownwards and to the right side, towards the cæcum, and divides into wo branches: one of these descends to inosculate with the termination f the mesenteric artery itself, and to form an arch, from the convexity f which branches proceed to supply the junction of the small with the rge intestine, and the cæcum and its appendix; the other division

Fig. 265.

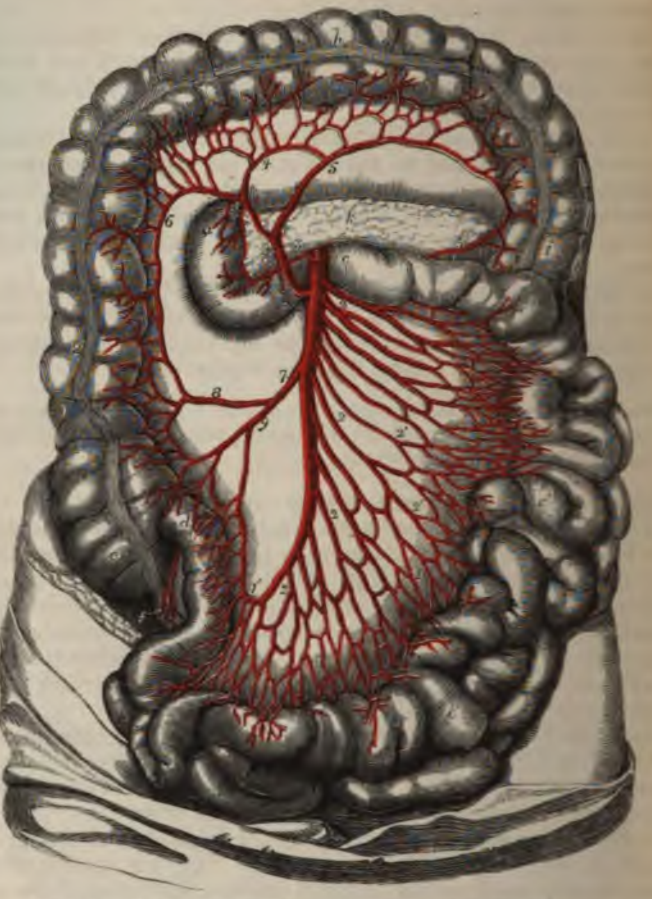


Fig. 265.—THE SUPERIOR MESENTERIC ARTERY AND ITS BRANCHES (from Tiedemann). ¼

The transverse colon is turned upwards; the jejunum and ileum are drawn to the left and the posterior layer of the transverse mesocolon and the anterior layer of the mesentery are removed: *a*, descending part of the duodenum; *b*, inferior transverse part; *c*, commencement of the jejunum; *c'*, *c'*, jejunum and ileum; *d*, termination of the ileum into the large intestine; *e*, cæcum; *f*, vermiform appendix; *g*, ascending colon; *h*, transverse colon; *i*, descending colon; *k*, pancreas; 1, trunk of the superior mesenteric artery; 1', its termination where it inosculates with a branch of the ileo-colic artery; 2, 2, intestinal branches; 2', 2', their loops in the mesentery; 3, inferior pancreatico-duodenal branch, passing to the right to unite with 3', the branch from the gastro-duodenal; 4, middle colic branch; 5, its left branch passing at 5', to unite with the branch of the left colic of the inferior mesenteric; 6, its right branch; 7, right colic and ileo-colic arteries in one trunk; 8, right colic, uniting by a loop with the middle colic; 9, ileo-colic, uniting with the end of the superior mesenteric artery.

ascends and inosculates with the next mentioned branch. The ileo-colic artery is not always distinct from the termination of the superior mesenteric.

2. The *right colic artery* passes transversely towards the right side, beneath the peritoneum, to the middle of the ascending colon, opposite which it divides into two branches; of these one descends to communicate with the ileo-colic artery, while the other ascends to join in an arch with the middle colic. This artery and the ileo-colic often arise by a common trunk.

3. The *middle colic artery* runs forwards between the layers of the transverse mesocolon towards the transverse colon, and divides in a manner exactly similar to that of the vessels just noticed. One of its branches inclines to the right, where it inosculates with the preceding vessel; the other passes to the left side, and forms a similar communication with the left colic branch, derived from the inferior mesenteric artery. From the arches of inosculation thus formed, small branches pass to the colon for the supply of its coats.

Those branches of the superior mesenteric artery which supply the ascending colon have a layer of peritoneum only on their anterior aspect; the others lie between two strata.

**Varieties.**—The number of the branches of the superior mesenteric artery, both intestinal and colic, is by no means constant. It also frequently gives off accessory branches to the neighbouring viscera; of these that to the liver is the most common. An offset of this artery may replace the gastro-duodenal or its chief branch, the right gastro-epiploic, or it may give accessory pancreatic and splenic branches (Hyrtl), or the artery to the gall-bladder. It has also been seen to give off the left colic artery, and in one case in which the inferior mesenteric was absent also the superior hæmorrhoidal (Fleischmann). A rare anomaly is the presence of an omphalo-mesenteric artery, arising either from the main stem or from one of the branches of the superior mesenteric. In one case it ran directly to the umbilicus where it gave a branch to the urachus (Haller). In another it reached the anterior wall of the abdomen rather below the umbilicus, and after giving a branch to the rectus, which anastomosed with the deep epigastric, it terminated by ascending in the round ligament, and forming a capillary network in the falciform ligament of the liver (Hyrtl).

The **inferior mesenteric artery** (iii–iv) arises from the front of the aorta between one and two inches above its bifurcation, and supplies the lower half of the large intestine. Inclining slightly to the left, it passes downwards close to the aorta, gives off branches to the descending colon and the sigmoid flexure, and is continued under the name of *superior hæmorrhoidal artery* over the left common iliac vessels to the back of the rectum.

*Branches.*—(*a*) The *left colic artery* is directed to the left side behind the peritoneum, and across the left kidney, to reach the descending colon. It divides into two branches, which form a series of arches in the same way as the colic vessels of the opposite side. One of these two branches passes upwards along the colon, and inosculates with the left branch of the middle colic; while the other descends and anastomoses with the sigmoid artery.

(*b*) The *sigmoid artery* runs obliquely downwards to the sigmoid flexure of the colon, where it divides into branches, which form arches like the other arteries; the highest branch joins the left colic, the lower ones turn downwards to the rectum and anastomose with the following artery. Instead of a single sigmoid artery, two or three branches are sometimes present.

(*c*) The *superior hæmorrhoidal artery*, the continuation of the inferior lobule, and enters the liver at the left end of the transverse fissure. The ramifications of the hepatic artery in the liver accompany the divisions of the portal vein and hepatic duct.

**Varieties.**—The hepatic artery sometimes arises from the superior mesenteric artery, or from the aorta itself. The left hepatic artery is not unfrequently derived from the coronary artery of the stomach, occasionally from the superior mesenteric, rarely from the splenic. Accessory hepatic arteries are sometimes met with, generally coming from the coronary artery, less frequently from the superior mesenteric, the aorta, the right renal, or the inferior mesenteric. The hepatic artery has been found to furnish a phrenic branch. The cystic artery has been seen arising from the superior mesenteric.

C. The **splenic artery (ii)**, in the adult the largest branch of the cœliac axis, supplies the spleen, and in part the stomach and pancreas. Waving and often tortuous in its course, it passes along the upper border of the pancreas, and divides near the spleen into several branches, which are distributed to that organ and to the left portion of the stomach.

*Branches.*—(*a*) *Pancreatic* branches, variable in size and number, are given off while the artery is passing along the pancreas, the body and tail of which they supply. One of larger size not unfrequently runs from left

Fig. 264.

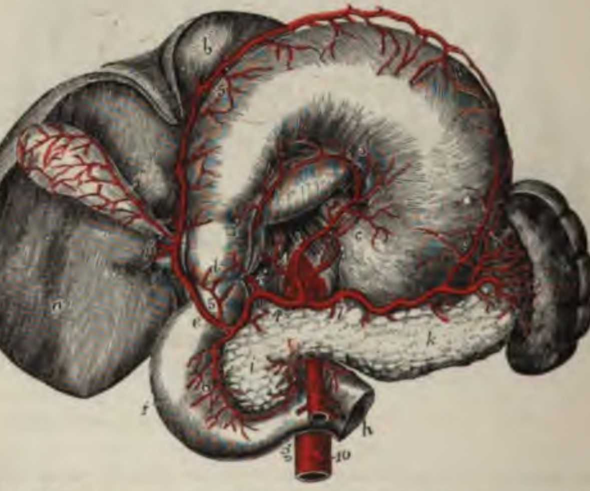


Fig. 264.—THE ARTERIES OF THE STOMACH, DUODENUM, PANCREAS, AND SPLEEN (from Tiedemann). ¼

The stomach and liver are turned upwards; the jejunum is divided at its commencement: *a*, right lobe of the liver; *b*, left lobe; *c*, cardiac orifice of the stomach; *d*, pylorus; *e*, first part, *f*, second part, and *g*, third part of the duodenum; *h*, commencement of the jejunum; *i*, head, and *k*, body of the pancreas; *l*, spleen; 1, 1, right and left inferior phrenic arteries passing from the aorta upon the crura of the diaphragm; 2, placed on the aorta close to the cœliac axis; 3, 3′, coronary artery; 4, common hepatic; 4′, 4′, proper hepatic artery and its right branch; 4″, cystic artery; 5, 5, right gastro-epiploic, and 6, superior pancreatico-duodenal, the two divisions of the gastro-duodenal; 7, splenic artery; 7′, splenic branches; 7″, one of the vasa brevia to the stomach; 8, 8, left gastro-epiploic artery, uniting with the right on the great curvature of the stomach; 9, trunk of the superior mesenteric artery, giving off the inferior pancreatico-duodenal; 10, inferior mesenteric.

to right in the direction of the pancreatic duct, and is called *arteria pancreatica magna.*

(*b*) The *splenic* branches are the proper terminal branches of the artery; they are five or six, or even more, in number, and vary in length and size; they enter the spleen by the hilus on its concave surface, and ramify within that organ.

(*c*) The *short gastric* branches (*vasa brevia*), from four to six in number, are directed forwards and to the right, some issuing from the trunk of the splenic artery, others from its terminal branches: they reach the left extremity of the stomach, where they divide and spread out between its coats, communicating with the coronary and left gastro-epiploic arteries.

(*d*) The left *gastro-epiploic artery* runs from left to right along the great curvature of the stomach, supplying branches to both surfaces of the stomach and to the omentum on the left side, and inosculates with the right gastro-epiploic branch from the hepatic artery.

**Varieties.**—These are not frequent. The splenic artery has been seen to give off the left hepatic artery, the middle colic artery, and in one case, together with the last, the inferior mesenteric artery.

The **superior mesenteric artery** (i) supplies the whole of the small intestine beyond the duodenum, and half of the large intestine. It arises from the fore part of the aorta, a little below the cœliac axis, and under cover of the pancreas and splenic vein. Emerging below the pancreas, it crosses the left end of the third part of the duodenum, and descends between the layers of the mesentery. Much diminished in size owing to the large number of its branches, it inclines below towards the right iliac fossa, and ends near the junction of the ileum with the large intestine by inosculating with its own ileo-colic branch.

*Branches.*—(*a*) The *inferior pancreatico-duodenal*, generally arising from the first intestinal branch and directed transversely to the right behind the main trunk, runs along the concave border of the duodenum, and joins with the superior pancreatico-duodenal artery.

(*b*) The *intestinal* branches, supplying the jejunum and ileum, spring from the convex or left side of the vessel. They are usually twelve or more in number, and are all included between the layers of the mesentery. They run parallel to one another for some distance, and then divide into two branches, each of which forms an arch with the neighbouring branch. From the first set of arches other branches issue, which divide and communicate in the same way, until finally, after forming from three to five such tiers of arches, the smaller as they are nearer to the intestine, the ultimate divisions proceed directly to the intestine, spreading upon both sides, and ramifying in its coats. Small offsets are also furnished to the glands and other structures between the layers of the mesentery.

(*c*) The *colic* branches arise from the right or concave side of the artery, and are usually three in number.

1. The *ileo-colic artery*, the first in order from below upwards, inclines downwards and to the right side, towards the cæcum, and divides into two branches: one of these descends to inosculate with the termination of the mesenteric artery itself, and to form an arch, from the convexity of which branches proceed to supply the junction of the small with the large intestine, and the cæcum and its appendix; the other division

Fig. 265.

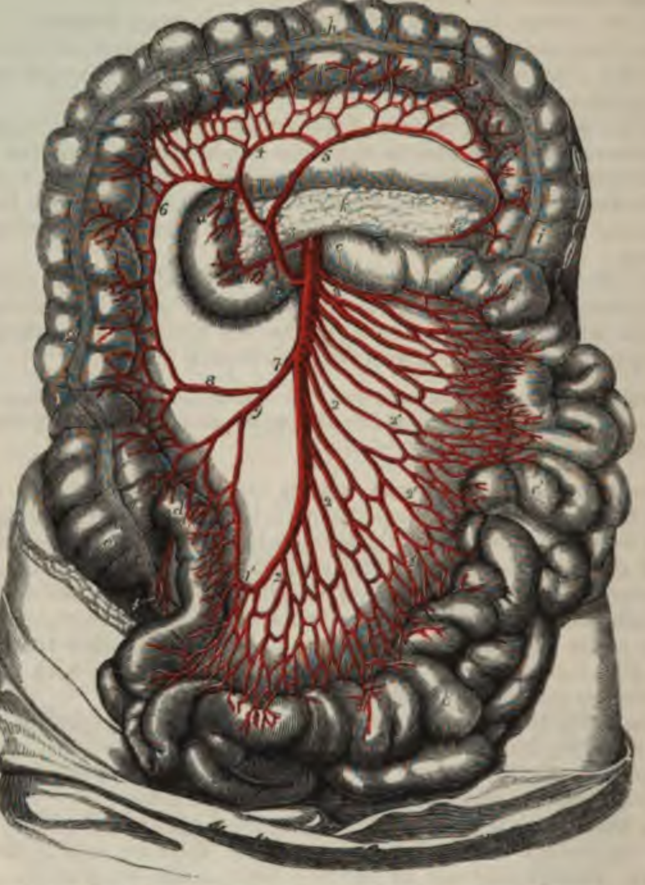


Fig. 265.—THE SUPERIOR MESENTERIC ARTERY AND ITS BRANCHES (from Tiedemann). ¼

The transverse colon is turned upwards; the jejunum and ileum are drawn to the left; and the posterior layer of the transverse mesocolon and the anterior layer of the mesentery are removed: *a*, descending part of the duodenum; *b*, inferior transverse part; *c*, commencement of the jejunum; *c'*, *c'*, jejunum and ileum; *d*, termination of the ileum in the large intestine; *e*, cæcum; *f*, vermiform appendix; *g*, ascending colon; *h*, transverse colon; *i*, descending colon; *k*, pancreas; 1, trunk of the superior mesenteric artery; 1', its termination where it inosculates with a branch of the ileo-colic artery; 2, 2, intestinal branches; 2', 2', their loops in the mesentery; 3, inferior pancreatico-duodenal branch, passing to the right to unite with 3', the branch from the gastro-duodenal; 4, middle colic branch; 5, its left branch passing at 5', to unite with the branch of the left colic of the inferior mesenteric; 6, its right branch; 7, right colic and ileo-colic arteries in one trunk; 8, right colic, uniting by a loop with the middle colic; 9, ileo-colic, uniting with the end of the superior mesenteric artery.

ascends and inosculates with the next mentioned branch. The ileo-colic artery is not always distinct from the termination of the superior mesenteric.

2. The *right colic artery* passes transversely towards the right side, beneath the peritoneum, to the middle of the ascending colon, opposite which it divides into two branches; of these one descends to communicate with the ileo-colic artery, while the other ascends to join in an arch with the middle colic. This artery and the ileo-colic often arise by a common trunk.

3. The *middle colic artery* runs forwards between the layers of the transverse mesocolon towards the transverse colon, and divides in a manner exactly similar to that of the vessels just noticed. One of its branches inclines to the right, where it inosculates with the preceding vessel; the other passes to the left side, and forms a similar communication with the left colic branch, derived from the inferior mesenteric artery. From the arches of inosculation thus formed, small branches pass to the colon for the supply of its coats.

Those branches of the superior mesenteric artery which supply the ascending colon have a layer of peritoneum only on their anterior aspect; the others lie between two strata.

**Varieties.**—The number of the branches of the superior mesenteric artery, both intestinal and colic, is by no means constant. It also frequently gives off accessory branches to the neighbouring viscera; of these that to the liver is the most common. An offset of this artery may replace the gastro-duodenal or its chief branch, the right gastro-epiploic, or it may give accessory pancreatic and splenic branches (Hyrtl), or the artery to the gall-bladder. It has also been seen to give off the left colic artery, and in one case in which the inferior mesenteric was absent also the superior hæmorrhoidal (Fleischmann). A rare anomaly is the presence of an omphalo-mesenteric artery, arising either from the main stem or from one of the branches of the superior mesenteric. In one case it ran directly to the umbilicus where it gave a branch to the urachus (Haller). In another it reached the anterior wall of the abdomen rather below the umbilicus, and after giving a branch to the rectus, which anastomosed with the deep epigastric, it terminated by ascending in the round ligament, and forming a capillary network in the falciform ligament of the liver (Hyrtl).

The **inferior mesenteric artery (iii–iv)** arises from the front of the aorta between one and two inches above its bifurcation, and supplies the lower half of the large intestine. Inclining slightly to the left, it passes downwards close to the aorta, gives off branches to the descending colon and the sigmoid flexure, and is continued under the name of *superior hæmorrhoidal artery* over the left common iliac vessels to the back of the rectum.

*Branches.*—(*a*) The *left colic artery* is directed to the left side behind the peritoneum, and across the left kidney, to reach the descending colon. It divides into two branches, which form a series of arches in the same way as the colic vessels of the opposite side. One of these two branches passes upwards along the colon, and inosculates with the left branch of the middle colic; while the other descends and anastomoses with the sigmoid artery.

(*b*) The *sigmoid artery* runs obliquely downwards to the sigmoid flexure of the colon, where it divides into branches, which form arches like the other arteries; the highest branch joins the left colic, the lower ones turn downwards to the rectum and anastomose with the following artery. Instead of a single sigmoid artery, two or three branches are sometimes present.

(*c*) The *superior hæmorrhoidal artery*, the continuation of the inferior *arteries)*, to the ureter, to the lumbar lymphatic glands, and several twigs which ramify in the connective tissue and fat around the kidney.

**Varieties.**—The renal artery may be replaced by two, three, four, or even five branches; and great differences as to the origin of these vessels are found to exist even on opposite sides of the same body. As they usually arise in succession from the aorta itself, it would seem as if the deviation were merely an increased degree of that condition in which the renal artery divides into branches sooner than usual after its origin. In some cases a renal artery has been seen to proceed from the aorta at its bifurcation, from the middle sacral artery, from the inferior mesenteric, from the common iliac, and in one case, described by Eustachius, from the internal iliac. Portal found in one instance the right and left renal arteries arising by a common trunk from the fore part of the aorta.

The branches of the renal artery, instead of entering at the hilus, sometimes reach and penetrate the gland near its upper end, or on its anterior surface. The right renal artery has been seen to cross the vena cava in front instead of behind. Supernumerary branches are also frequently found. The most common are, the diaphragmatic arising in common with the inferior suprarenal, a hepatic branch from the right renal, branches to the small and large intestines, the middle suprarenal, the spermatic, and one or more lumbar arteries.

**Spermatic** and **ovarian arteries (v)**.—The **spermatic arteries** of the male, two small and very long vessels, arise close together from the fore part of the aorta a little below the renal arteries. Each artery is directed downwards and somewhat outwards, resting on the psoas muscle, that of the right side passing also in front of the inferior vena cava; it crosses obliquely the ureter and the lower part of the external iliac artery, and reaches the internal abdominal ring. There it comes into contact with the vas deferens, and passes with the other constituents of the spermatic cord along the inguinal canal, forming anastomoses with the cremasteric branch of the epigastric artery. Issuing by the external abdominal ring, it descends to the scrotum, where it becomes tortuous, and, approaching the back part of the testis, divides into branches which pierce the fibrous capsule of that body. One or two branches ramify on the epididymis and anastomose with the artery of the vas deferens.

In the female, the **ovarian arteries**, corresponding to the spermatic arteries in the male, are shorter than these vessels, and do not pass out of the abdominal cavity. The origin, direction, and connections of the artery in the first part of its course are the same as in the male; but at the margin of the pelvis it inclines inwards, and, running tortuously between the layers of the broad ligament of the uterus, is guided to the attached margin of the ovary, which it supplies with branches. One small offset extends along the round ligament into the inguinal canal, another along the Fallopian tube, and a third, of considerable size, running inwards towards the uterus, joins with the uterine artery. During pregnancy the ovarian artery becomes considerably enlarged.

In early fœtal life the spermatic and ovarian arteries are short, as the testes and the ovaries are at first placed close to the kidneys, but the arteries become lengthened as these organs descend to their ultimate positions.

**Varieties.**—The spermatic artery is frequently derived from the renal, occasionally from the suprarenal, on one side. The right and left arteries occasionally arise by a common trunk. Two spermatic arteries are not unfrequently met with on one side; both of these usually arise from the aorta, though sometimes one is a branch of the renal artery. A case has occurred of three arteries on one side,—two from the aorta and the third from the renal (R. Quain, pl. 57, fig. 5.)

### B.—PARIETAL BRANCHES OF THE ABDOMINAL AORTA.

**Inferior phrenic arteries (v).**—The inferior phrenic or diaphragmatic arteries are two small vessels, which arise, either separately or by a short common trunk, from the aorta on a level with the upper margin of its orifice in the diaphragm, or from one of the upper branches of the aorta, most frequently the cœliac axis. They soon diverge from each other, and, passing across the crura of the diaphragm, incline upwards and outwards on its under surface, the artery of the left side passing behind the œsophagus, while that of the right side passes behind the vena cava. Before reaching the central tendon of the diaphragm, each of the arteries divides into two branches, of which one runs forwards towards the anterior margin of the thorax, and anastomoses with the corresponding artery of the opposite side, and with the superior phrenic and musculo-phrenic branches of the internal mammary artery, while the other pursues a transverse direction towards the side of the thorax, and communicates with the terminations of the lower intercostal arteries.

Besides supplying the diaphragm, each phrenic artery gives small branches (*superior suprarenal*) to the suprarenal body of its own side; the left artery sends some branches to the œsophagus, which anastomose with the other œsophageal arteries; and the artery of the right side gives some twigs to the upper part of the vena cava. Small offsets pass also to the liver between the layers of the peritoneum, and anastomose with branches of the hepatic artery.

**Varieties.**—The phrenic arteries vary greatly in their mode of origin, but these deviations seem to have little influence on their course and distribution. In the first place they may arise either separately, or by a common trunk; and it would appear that the latter mode of origin is nearly as frequent as the former. When the two arteries are joined at their origin, the common trunk arises most frequently from the aorta; though, sometimes, it springs from the cœliac axis. When arising separately, the phrenic arteries are given off sometimes from the aorta, more frequently from the cœliac axis, and occasionally from the coronary artery of the stomach, or the renal; but it most commonly happens that the artery of the right side is derived from one, and that of the left side from another of these sources. One artery has also been seen arising from the superior mesenteric. In only one out of thirty-six cases observed by R. Quain did these arteries arise as two separate vessels from the abdominal aorta (*op. cit.* p. 417). An additional phrenic artery, derived from the left hepatic, has been met with (R. Quain, pl. 56, fig. 6).

**Lumbar arteries (iv-v).**—The lumbar arteries resemble the intercostal arteries, not only in their mode of origin, but also in a great measure in the manner of their distribution. They arise from the back part of the aorta, and are usually five in number on each side. They pass outwards, the first one over the body of the last dorsal vertebra, while the others rest on the upper four lumbar vertebræ, and soon dip deeply under the psoas muscle. The upper arteries are likewise behind the pillars of the diaphragm; and those on the right side are covered by the vena cava. At the interval between the transverse processes, each lumbar artery divides into an abdominal and a dorsal branch.

*Branches.*—(*a*) The *abdominal* branch runs outwards, generally behind the quadratus lumborum, but that of the first artery passes in front of this muscle with the anterior division of the last dorsal nerve, and a similar position is not unfrequently taken by one or two of the lower

Fig. 267.

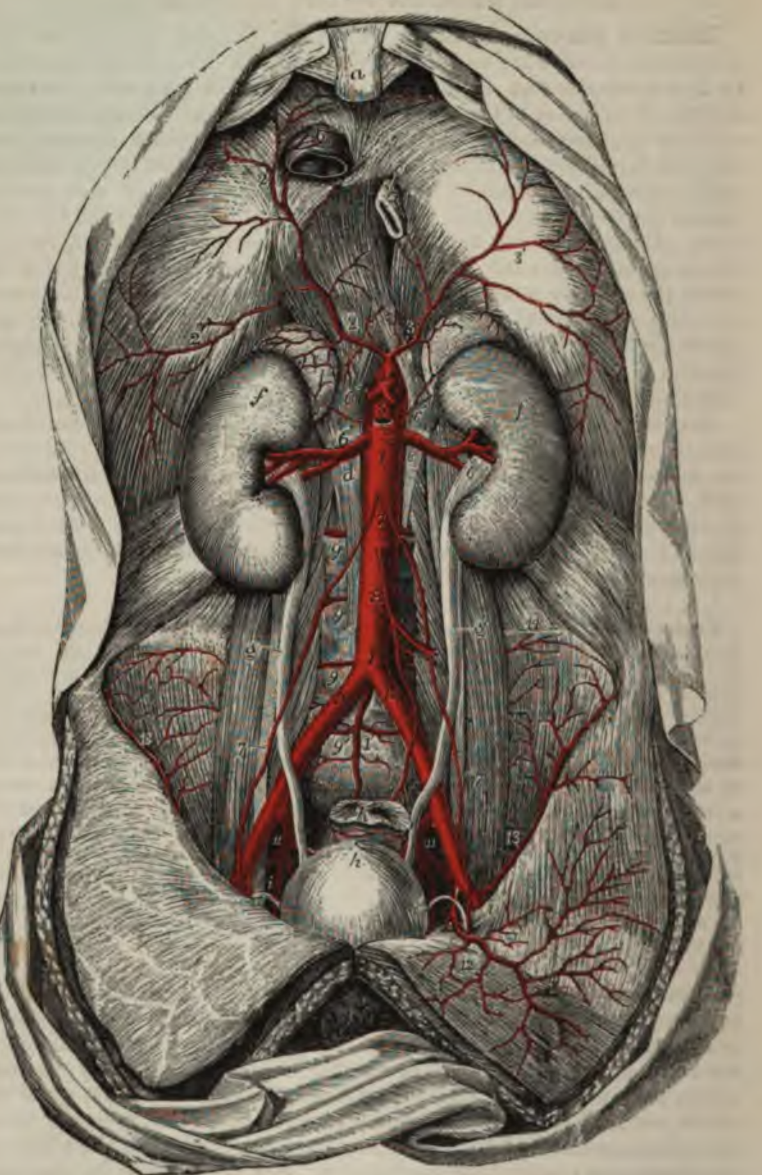


Fig. 267.—The abdominal aorta and its principal branches (from Tiedemann). ¼

For the detailed description of this figure, see p. 434. 6, renal arteries; 6′, 6′, middle suprarenal arteries, arising from the aorta; the upper suprarenal arteries are seen proceeding from the inferior phrenic; 7, placed on the abdominal aorta below the origin of the spermatic arteries; 7, 7′, lower down, the same arteries descending on the psoas muscles and crossing the ureters, that on the left side entering the internal abdominal ring with the vas deferens *i*; 8, inferior mesenteric artery; 9, lumbar arteries; 9′, a lowest lumbar artery, rising from the middle sacral 1′, (see varieties of the latter vessel); 10, 10′, right and left common iliac arteries; 11, 11, between the external and internal iliac arteries; 12, left epigastric artery; 13, circumflex iliac artery.

ones. Continuing outwards between the abdominal muscles, the vessel ramifies in their substance, and the several arteries form anastomoses with one another, with the branches of the epigastric and internal mammary in front, with the terminal branches of the lowest intercostals above, and with offsets of the ilio-lumbar and circumflex iliac arteries below.

(*b*) The *dorsal* branch, like the posterior branch of an intercostal artery, gives off immediately after its origin an offset to the spinal canal, and then, proceeding backwards between the transverse processes with the posterior division of the corresponding spinal nerve, divides into smaller vessels which are distributed to the muscles and integument of the back.

The *spinal* branch enters the spinal canal through the corresponding intervertebral foramen, gives an offset which supplies the dura mater and ascends along the roots of the nerves to the spinal cord (see p. 393), and divides into two principal branches which are distributed to the bones and ligaments in the following manner:—one curves upwards on the back of the body of the vertebra above, near to the attachment of the pedicle, while the other descends in a similar manner on the vertebra below; and each communicates with a corresponding branch from the neighbouring spinal artery. As this arrangement prevails on both sides and throughout the whole length of the spine, there is formed a double series of arterial arches behind the bodies of the vertebræ, the convexities of which are turned towards each other. From the arches on opposite sides offsets are directed inwards at intervals to reinforce a median longitudinal vessel, which extends along the spine like the single artery on the front of the spinal cord. The arches are moreover joined together across the bodies of the vertebræ by transverse branches. Other small twigs pass backwards from the spinal branch, and anastomosing with their fellows form an irregular network on the anterior surface of the arches of the vertebræ and the ligamenta subflava. From these interlacements numerous minute ramifications proceed to the ligaments, the periosteum and the bones.

**Varieties.**—The lumbar arteries of opposite sides, instead of taking their origin separately from the aorta, occasionally commence by a common trunk, the branches of which pass out laterally, and continue their course in the ordinary way. Two arteries of the same side are sometimes conjoined at their origin. One or both of the last pair of lumbar arteries may arise in common with the middle sacral. On the fifth lumbar vertebra, the place of a lumbar artery is often taken by a branch from the middle sacral artery, and the ilio-lumbar compensates for the absence of the lumbar vessel amongst the muscles.

### MINUTE ANASTOMOSES OF THE VISCERAL AND PARIETAL BRANCHES OF THE ABDOMINAL AORTA.

The existence of minute anastomoses between some of the visceral branches of the abdominal aorta and those supplying the wall of the cavity has been recognised by several anatomists, but the extent and nature of these communications were first clearly demonstrated by W. Turner in a series of experimental injections, made with a view to their detection (Brit. and For. Med. Chir. Rev., July, 1863).

These anastomoses constitute a well-marked vascular plexus, situated in the subperitoneal tissue, which Turner calls the *subperitoneal arterial plexus.* It occupies the lumbar region from the diaphragm downwards into the iliac regions and pelvis, and establishes communication between the parietal vessels and those of the viscera, chiefly, though not exclusively, through branches of the arteries of those viscera which are situated behind the peritoneum. It belongs to the hepatic, the renal and suprarenal arteries, those of the pancreas and duodenum, the cæcum, and the ascending and descending parts of the colon. It extends also to the vessels of the rectum, and to the spermatic arteries, both in their descent through the abdomen and in the inguinal canal and scrotum.

In these situations it was found that the injected material (coloured gelatine) when thrown into the vessels of the viscus, so as to fill them completely, extended through the subperitoneal plexus in various ways, so as to reach one or other set of parietal vessels, such as the phrenic, lumbar, ilio-lumbar, circumflex iliac, lower intercostal, and epigastric arteries; in the pelvis, the middle and lateral sacral arteries; and in the scrotum, the superficial pudic and perineal arteries.

The more direct inosculations of the hæmorrhoidal arteries on the rectum with the inferior hæmorrhoidal branches of the pudic artery are well known, and the importance of these and other similar anastomoses, as well as the more extensive and minute anastomosing plexus investigated by Turner, is obvious, with reference not merely to the nutrition of the subperitoneal tissue, but also to the debated question of the influence exerted by local superficial blood-letting on the state of the vessels of the deeper viscera.

**Middle sacral artery (iv).**—The middle sacral artery arises from the back of the aorta just above the bifurcation. From this point it proceeds downwards, over the last lumbar vertebra and along the middle of the sacrum, to the front of the coccyx, where it forms slender arches of anastomosis with the lateral sacral arteries, and is then continued as a small vessel through the median aponeurosis of the levatores ani muscles to terminate in the coccygeal gland (see Vol. II., p. 197).

From the front of the middle sacral artery small branches pass into the fold of the mesorectum, and ramify upon the posterior surface of the intestine, anastomosing with the hæmorrhoidal arteries; and on each side others spread out upon the sacrum, and anastomose with the lateral sacral arteries, occasionally sending small offsets into the anterior sacral foramina.

**Varieties.**—The middle sacral artery sometimes deviates a little to one side. It may arise in common with one or both of the fifth pair of lumbar arteries, or from the bifurcation of the aorta, or from one of the common iliac arteries, more frequently the left. It often gives off on each side a considerable branch (*lowest lumbar artery*), which passes backwards on the fifth lumbar vertebra (fig. 267, 9'). The middle sacral artery has also been seen to furnish an accessory renal, or a middle hæmorrhoidal artery. This artery represents the caudal prolongation of the aorta of animals, and its lateral branches may be regarded as corresponding to the intercostal and lumbar arteries.

### COMMON ILIAC ARTERIES.

The common iliac arteries (11-12 mm.), commencing at the bifurcation of the aorta, pass downwards and outwards, diverging from each other at an angle which is slightly greater in the female than in the male, and divide opposite the lumbo-sacral articulation into the internal and external iliac arteries.

The common iliac arteries measure generally about two inches in length. Both are covered by the peritoneum and the small intestine, and are crossed by the branches of the sympathetic nerve which pass from the aortic to the hypogastric plexus, as well as usually by the ureter near their point of division; the artery of the left side is crossed also by the superior hæmorrhoidal vessels. The left common iliac artery lies close to the inner border of the psoas muscle, and rests upon the bodies of the fourth and fifth lumbar vertebræ; the right artery is separated for the most part from these bones by the two common iliac veins, and touches the psoas muscle only at its lower end.

Fig. 268.

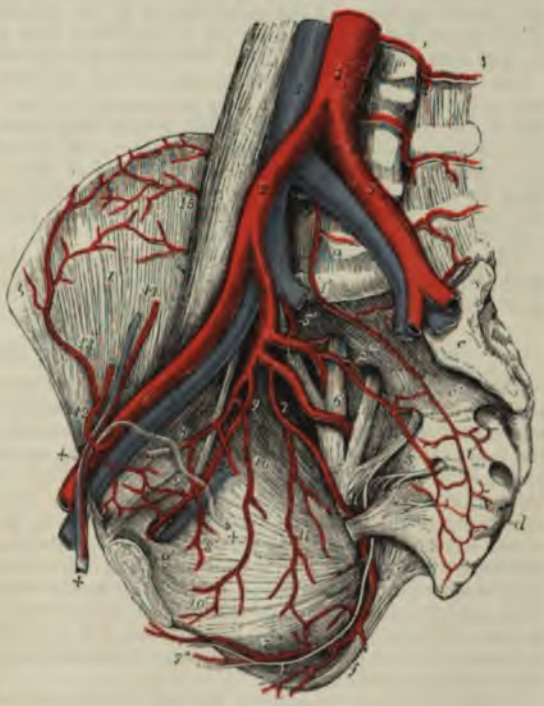


Fig. 268.—THE RIGHT SIDE OF A MALE PELVIS SHOWING THE ILIAC ARTERIES AND THEIR BRANCHES. (A. T.) $\frac{1}{3}$

The viscera of the pelvis have been removed, as well as the internal iliac veins; the larger nerves have been left: *a*, body of the fifth lumbar vertebra; *b*, anterior superior spine of the ilium; *c*, left auricular surface of the sacrum; *c'*, third piece of the sacrum; *d*, first piece of the coccyx; *e*, small sacro-sciatic ligament; *f*, tuberosity of the ischium, covered internally by the great sacro-sciatic ligament; *g*, aperture at the upper end of the obturator foramen; *i*, iliacus muscle; 1, abdominal aorta; 1', middle sacral artery; 2, 2, common iliac arteries; 2' right external iliac; 3, inferior vena cava; 4, 4, common iliac veins; the number on the right points by a line to the right internal iliac artery; 4', right external iliac vein; 5, placed on the lumbo-sacral nervous trunk, points to the posterior division of the internal iliac artery continued into the gluteal; 5', ilio-lumbar artery; 5'', lateral sacral artery, with branches passing into the anterior sacral foramina; 6, placed on the anterior division of the first sacral nerve, points to the sciatic artery coming from the anterior division of the internal iliac; 7, pudic artery; 7', the same artery passing behind the spine of the ischium, and proceeding forwards on the inner side of the obturator internus muscle, accompanied by the pudic nerve, and giving off, near *f*, inferior hæmorrhoidal branches; 7'', superficial perineal artery and nerve; 8, obliterated hypogastric artery, cut short, and 8', superior vesical branches rising from it; 9, obturator artery with the corresponding nerve and vein; 9', pubic twigs which anastomose with the pubic branch of the epigastric artery; 10, inferior vesical; 11, middle hæmorrhoidal artery, rising in this instance from the pudic; 12, epigastric artery, winding to the inner side of +, +, the vas deferens and spermatic cord; 13, circumflex iliac artery; 14, spermatic artery and vein divided superiorly; 15, twigs of the ilio-lumbar artery proceeding to anastomose with the circumflex iliac.

*Relation to veins.*—The *left common iliac vein* lies to the inner side of and below the left artery. On the right side there are three veins in proximity to the artery; the *right common iliac vein* lying behind the lower part of the vessel, the *left common iliac vein* crossing behind it above its middle, and the *inferior vena cava*, resulting from the union of the two others, being on the right side of the artery at its upper end.

The common iliac artery usually does not furnish any named collateral branches. A few minute twigs are given to the psoas muscle, to the ureter, and to the neighbouring lymphatic glands.

**Varieties.**—The *place of division* of these arteries is subject to great variety. In two-thirds of a large number of cases, it ranged between the middle of the last lumbar vertebra and the upper margin of the sacrum; in one case in eight it was above, and in one case in six it was below that space. Most frequently the left artery was found to divide lower than the right (R. Quain).

The *length* varies in most instances between an inch and a half and three inches, but it has been seen in some rare cases less than half an inch, and as long as four inches and a half. When longer than usual the artery is generally more or less tortuous. In two instances absence of one common iliac artery has been observed, the internal and external iliacs of that side springing directly from the end of the aorta (on the right side by Cruveilhier, "Anatomie," 5th Ed., iii., 150; on the left side by W. J. Walsham, St. Bartholomew's Hosp. Rep. xvii., 1881).

*Branches.*—The common iliac artery occasionally gives off the middle sacral, ilio-lumbar or upper lateral sacral artery, more rarely a lumbar or an accessory renal artery.

### SURGICAL ANATOMY OF THE COMMON ILIAC ARTERY.

The common iliac artery may be reached in an operation by dividing the abdominal muscles in the lumbar region. A semilunar incision, having its convexity turned outwards, may be carried from a point an inch and a half to the inner side of the anterior superior iliac spine, upwards and somewhat outwards, to near the lower margin of the thorax. The external oblique, internal oblique, and transversalis muscles are successively divided, together with the thin transversalis fascia; the peritoneum, to which the ureter and spermatic vessels adhere closely, is next separated from the lateral abdominal wall and the surface of the psoas until the artery is reached; the areolar sheath is then scraped through and the ligature applied, the needle being passed on either side from right to left. It seldom happens that the common iliac artery is too short to allow of the application of a ligature, but if it were found to be less than an inch and a half in length, the external and internal iliac trunks might be secured close to the bifurcation.

*Collateral circulation.*—After ligature of the common iliac artery, blood is conveyed to the external iliac trunk through the anastomoses of the circumflex iliac with the lumbar arteries, and of the epigastric with the internal mammary; to the internal iliac through the anastomoses of the middle with the lateral sacral arteries, of the lumbar with the ilio-lumbar, of the superior with the middle and inferior hæmorrhoidal, and of the obturator and the arteries supplied to the pelvic viscera with the corresponding vessels of the opposite side.

## INTERNAL ILIAC ARTERY (II).

The internal iliac artery (hypogastric) extends from the bifurcation of the common iliac artery downwards towards the great sacro-sciatic foramen, near the upper border of which it divides into branches. It is generally from an inch to an inch and a half in length, and is smaller than the external iliac in the adult, but the reverse in the fœtus. At its origin, tery lies near the inner border of the psoas muscle; lower down, it rests against the sacrum and lumbo-sacral nervous cord. It is covered by the layer of peritoneum constituting the posterior false ligament of the bladder, and beneath this the ureter crosses it on the inner side. The companion vein lies behind, and somewhat to its inner side, and the commencement of the artery crosses the upper end of the external iliac vein.

BRANCHES.—The branches of the internal iliac artery, though constant and regular in their general distribution, vary much in their mode of origin. They arise, in most instances, from two principal divisions of the parent trunk, of which one is anterior to the other. From the *anterior division* arise the superior vesical (connected with the pervious portion of the fœtal hypogastric artery), the inferior vesical (vaginal in the female), middle hæmorrhoidal, obturator, internal pudic, and sciatic arteries, and also, in the female, the uterine artery. The *posterior division* gives off the ilio-lumbar and lateral sacral arteries, and is continued into the gluteal.

**Varieties.**—*Length.*—The internal iliac artery has been found as short as half an inch, and sometimes as long as three inches, but it is not often less than an inch in length. Two instances are recorded in which this vessel was absent on the left side, and its branches were derived from a loop of the external iliac artery dipping down into the pelvis (Ellis, Eckhard). The lengths of the common and internal iliac arteries generally bear an inverse proportion to each other—the internal iliac being long when the common iliac is short, and *vice versâ.* Moreover, when the common iliac is short, the internal iliac (arising higher than usual) is placed for some distance above the brim of the pelvis, and descends by the side of the external iliac to reach that cavity.

The *place of division* of the internal iliac into its branches varies between the upper margin of the sacrum and the upper border of the sacro-sciatic foramen.

*Branches.*—Sometimes all the branches of the internal iliac artery arise without the previous separation of that vessel into two portions.

In more than a fourth of R. Quain's cases a branch, most frequently the ilio-lumbar artery, arose from the internal iliac trunk before its subdivision.

**Hypogastric artery.**—In the fœtus, the hypogastric artery, retaining almost the full size of the common iliac, curves forwards from that artery to the side of the urinary bladder, and ascends on the anterior wall of the abdomen to the umbilicus. At that point the artery takes the name of *umbilical,* and the vessels of the two sides, coming into contact with one another, and with the umbilical vein along with which they are spirally coiled, proceed in the umbilical cord to the placenta. After the cessation of the placental circulation at birth, the hypogastric arteries become impervious from the side of the bladder upwards to the umbilicus, and are converted into fibrous cords. These two cords, being shorter than the part of the peritoneum on which they rest, cause a fold of the serous membrane to project inwards; and thus are formed two fossæ at the fore part of the abdomen on each side of the middle line, in one or other of which the projection of an internal inguinal hernia takes place. The proximal part of the artery persists as the internal iliac, and the portion intervening between this and the side of the bladder remains pervious, although proportionally much reduced in size, and forms the trunk of the superior vesical artery.

### BRANCHES OF THE INTERNAL ILIAC ARTERY.

1. The **superior vesical artery** (v) is, at its commencement, that part of the hypogastric artery of the fœtus which remains pervious after the changes that take place subsequently to birth. It divides into numerous branches which supply the apex and body of the bladder, and anastomose with the corresponding vessels of the opposite side, as well as with the offsets of the inferior vesical artery. Anteriorly, small twigs ascend on the urachus to the abdominal wall, and posteriorly, others supply the lower end of the ureter. One or more of the hindmost

branches of this artery are sometimes described separately under the name of *middle vesical.*

**2.** The **inferior vesical artery** (**v**) (vesico-prostatic), derived usually from the anterior division of the internal iliac, is directed downwards to the base of the bladder, where it ends in branches which are distributed to the lower part of that organ, to the prostate, and to the vesiculæ seminales. The branches to the prostate communicate more or less freely upon that body with the artery of the opposite side, and by small descending twigs also with the arteries of the perineum (Haller). It occasionally happens that one of the latter offsets is much enlarged, and replaces one or more branches of a defective pudic artery, as will be more fully noticed in the description of that vessel.

Fig. 269.

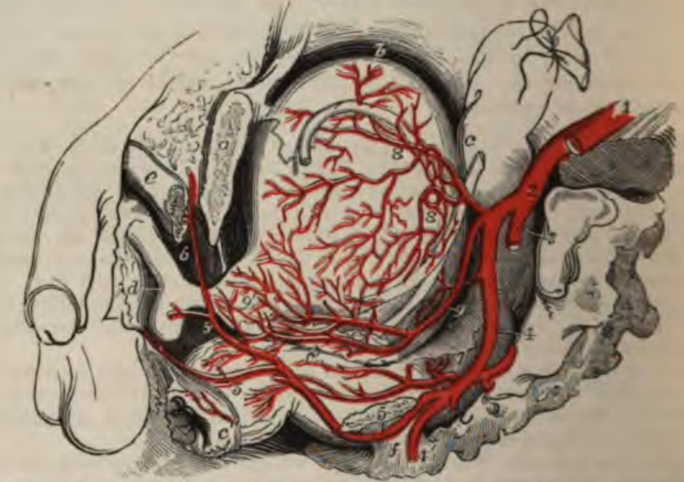


Fig. 269.—View of the viscera of the male pelvis from the left side, showing the vesical and pudic arteries (from R. Quain). ⅓

*a*, os pubis, divided a little to the left of the symphysis; *b*, placed close to the upper part of the bladder, upon which lies the vas deferens; *c*, placed on the upper part of the rectum, near the left ureter; *c′*, at the junction of the middle and lower parts of the rectum, points to the vesicula seminalis; *c″*, anus; *d*, bulb of the urethra; *e*, crus penis divided; *f*, small sacro-sciatic ligament, attached to the spine of the ischium; 1, common iliac artery; 2, internal iliac artery; 3, gluteal artery cut short; 4, common trunk of the sciatic and pudic arteries; 4′, sciatic artery, cut as it is passing out of the great sacro-sciatic foramen; 5, placed on the divided surface of the ischial spine, points to the pudic artery as it is about to enter the perineum by the small sacro-sciatic foramen; 5′, superficial perineal branch of the pudic; 5″, pudic artery, giving off the artery of the bulb, and proceeding at 6, to divide into the artery of the corpus cavernosum and the dorsal artery of the penis; 7, placed on the middle part of the rectum, points to the descending branches of the superior hæmorrhoidal artery; 8, 8, ramifications of the superior vesical artery; 9, inferior vesical artery, of considerable size in this instance, giving branches to the bladder, the vesicula seminalis, the rectum (middle hæmorrhoidal), and 9′, to the prostate gland.

One slender but constant branch, the *artery of the vas deferens* (vi), arising from either the superior or inferior vesical artery, sends one or more twigs downwards to the lower part of the vas deferens and the vesicula seminalis, and is then continued forwards along the vas deferens, in company with which it descends in the spermatic cord as far as the testicle, where it anastomoses with the spermatic artery. This branch may reinforce or even replace the last-mentioned vessel.

Besides the superior and inferior vesical arteries, other small offsets are frequently furnished to the bladder from the obturator, sciatic, or other branches of the internal iliac artery.

The **vaginal artery** (**v**) (vesico-vaginal) in the female corresponds to the inferior vesical artery in the male. Arising from the anterior division of the internal iliac, or frequently from the uterine artery, it descends and ramifies upon the vagina, sending at the same time offsets to the lower part of the bladder, to the bulb of the vestibule, and to the contiguous part of the rectum. It anastomoses behind the vagina with the corresponding artery of the opposite side.

Fig. 270.

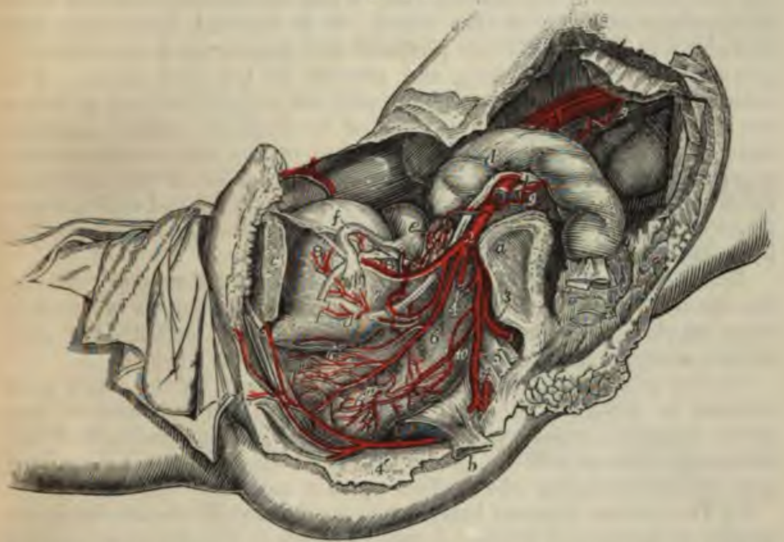


Fig. 270.—THE ARTERIES OF THE FEMALE PELVIS, AS SEEN ON THE REMOVAL OF THE LEFT HIP-BONE, &c. (from R. Quain). ¼

*a*, auricular surface of the sacrum; *b*, spine of the ischium with the small sacro-sciatic ligament; *c*, os pubis, divided a little to the left of the symphysis; *d*, on the sigmoid part of the colon, and *d′*, on the lower part of the bladder, point to the ureter; *e*, on the upper part of the body of the uterus, points to the ovary; *f*, on the upper part of the bladder, points to the Fallopian tube; *f′*, round ligament of the uterus; 1, external iliac artery cut short; 2, internal iliac artery; 3, gluteal artery cut short; 4, 4, left pudic artery from which a part has been removed; 4′, the same artery in the perineum, and 4″, its last part, proceeding to divide into the dorsal and deep arteries of the clitoris; 5, placed on the sacral nerves, points to the sciatic artery; 6, vaginal artery, giving off branches to the bladder 6′, and to the rectum 6″; 7, uterine artery; 8, superior vesical, and 8′, obliterated hypogastric artery; 9, 9, ovarian artery, descending from the aorta; 10 superior hæmorrhoidal artery, spreading over the side of the rectum.

**3.** The **middle hæmorrhoidal artery** (**v**) is frequently derived from the inferior vesical or the internal pudic artery. It ramifies on the lower part of the rectum, and anastomoses with the other hæmorrhoidal and the inferior vesical arteries.

4. The **uterine artery** (v) is directed inwards from the anterior division of the internal iliac towards the neck of the uterus. Insinuating itself between the layers of the broad ligament, it passes upwards on the side of the uterus, pursuing an exceedingly tortuous course, and sends off numerous branches, which ramify on the anterior and posterior surfaces and in the substance of that organ. Near its termination it is joined by a branch of the ovarian artery, forming an arch from which offsets proceed to the Fallopian tube and the round ligament of the uterus. During pregnancy the uterine artery becomes much enlarged.

5. The **obturator artery** (iv), while it usually arises from the anterior division of the internal iliac, is not unfrequently derived from the posterior division of that vessel. It is directed downwards and forwards a little below the ilio-pectineal line, resting upon the obturator portion of the pelvic fascia, and covered by the peritoneum. The obturator nerve is a little way above, and the companion vein is below the artery. Reaching the upper part of the thyroid foramen, it passes through a short canal formed by the groove on the under surface of the superior ramus of the pubis and the arched border of the obturator fascia (p. 336), and divides immediately into internal and external terminal branches, which descend on the surface of the obturator membrane, beneath the obturator externus muscle.

*Branches.*—(*a*) Within the pelvis, besides other small muscular offsets, the obturator artery furnishes an *iliac* branch which ramifies in the iliac fossa, supplying the ilio-psoas muscle and anastomosing with the ilio-lumbar artery, and sometimes a branch to the urinary bladder.

(*b*) One or two small *pubic* branches are given off by the artery as it is about to leave the pelvis: these vessels ramify on the back of the pubis, and communicate behind the bone and the attachments of the abdominal muscles with the pubic branch of the epigastric artery, and with the corresponding offsets of the opposite side.

(*c*) The *internal terminal* branch, turning downwards close to the inner margin of the thyroid foramen, furnishes offsets to the obturator muscles and to the upper ends of the adductors, and anastomoses with branches of the internal circumflex artery.

(*d*) The *external terminal* branch descends near the outer margin of the thyroid foramen, sends a small offset inwards to anastomose with the lower part of the internal branch, and then, inclining outwards in the groove below the acetabulum, is distributed to the muscles arising from the ischial tuberosity and anastomoses with branches of the sciatic artery. It also gives twigs to the obturator muscles; and one small branch, entering the hip-joint through the cotyloid notch, supplies the fat and synovial membrane at the bottom of the acetabulum, and ramifies in the interarticular ligament as far as the head of the femur.

**Varieties.**—The obturator artery frequently has its origin transferred to the commencement of the epigastric artery, and sometimes to the external iliac near its termination.

In 361 cases observed by R. Quain, the origin of the obturator artery took place as follows. In the proportion of 2 cases out of 3, it arose from the internal iliac; in 1 case out of 3½, from the epigastric; in a very small number of cases (about 1 in 72) it arose by two roots, one from each of the above-named vessels; and in about the same proportion, from the external iliac artery.

Sometimes the obturator artery arises from the epigastric on both sides of the same body, but in the majority of instances this mode of origin of the vessel is met with only on one side.

When the obturator artery arises from the epigastric, it turns backwards into the pelvis to reach the canal at the upper part of the thyroid foramen; and in this course it is necessarily close to the crural ring, the opening situated at the inner side of the external iliac vein, through which hernial protrusions descend from the abdomen into the thigh. Out of 101 cases observed by R. Quain, the artery turned backwards close to the external iliac vein, and therefore on the outer side of the crural ring, in 54; it passed backwards across the ring in 37; and in the remaining 10 it was directed at first inwards, and then arched backwards on the inner side of the ring: the point at which this artery separated from the epigastric was not found to exercise any influence upon its relation to the crural ring (*op. cit.*, pp. 451-454). It is when the artery is placed on the inner side of the ring that it is liable to be wounded in the operation for dividing the stricture in a femoral hernia.

Fig. 271.

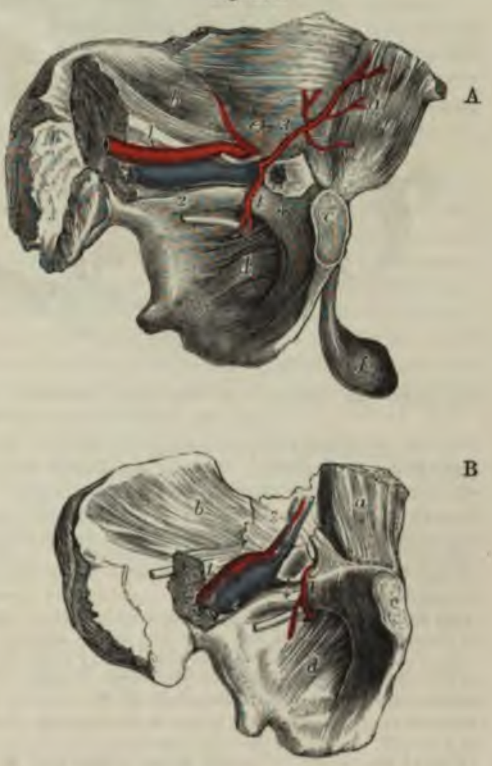


Fig. 271, A. and B.—VIEWS OF THE LEFT HIP-BONE, WITH THE ATTACHED ABDOMINAL MUSCLES, FROM THE INSIDE, SHOWING DIFFERENT POSITIONS OF THE ABERRANT OBTURATOR ARTERY. (R. Quain.) $\frac{1}{4}$

In A, the aberrant artery passes to the outer side of a femoral hernia; in B, it surrounds the neck of the sac.

*a*, rectus muscle; *b*, iliacus muscle; *c*, symphysis pubis; *d*, obturator membrane; *e*, placed on the transversalis fascia, points to the vas deferens passing through the internal abdominal ring; *f*, testicle; +, neck of a femoral hernial sac; 1, external iliac artery; 2, external iliac vein; below 2, the obturator nerve; 3, epigastric artery, giving off 4, the aberrant obturator artery.

The anastomosis which normally exists between the pubic branches of the obturator and epigastric arteries explains the nature of the change which takes place when the origin of the obturator artery is transferred from the one place to the other. In such cases one of the anastomosing vessels may be supposed to have become enlarged, and the posterior or proper root of the obturator artery to have remained undeveloped or to have become obliterated in a proportionate degree.

The obturator artery has also been seen to arise from the upper part of the femoral, either alone or in conjunction with the internal circumflex artery, in which case it arches backwards over the superior ramus of the pubis, and through the crural ring, to reach the thyroid foramen.

In a few cases the obturator artery has been observed giving off the epigastric artery, an accessory pudic artery (within the pelvis), or the dorsal artery of the penis (in the thyroid foramen).

**6.** The **internal pudic artery (iv)**, one of the terminal branches of the anterior division of the internal iliac, is distributed to the perineum and the external organs of generation. The following description of the artery has reference to its arrangement in the male, and the differences which it presents in the female will be afterwards pointed out.

From its origin in front of the pyriformis muscle, the pudic artery descends along with the sciatic artery, and leaves the pelvis by the lower part of the great sacro-sciatic foramen. Then curving gradually forwards, it crosses over the ischial spine and passes through the small sacro-sciatic foramen into the posterior division of the perineal space, where it lies along the outer wall of the ischio-rectal fossa, being placed from an inch to an inch and a half above the lower margin of the ischial tuberosity. Continuing its course forwards, it gradually approaches the margin of the ischial ramus, penetrates the base of the triangular ligament,

Fig. 272.

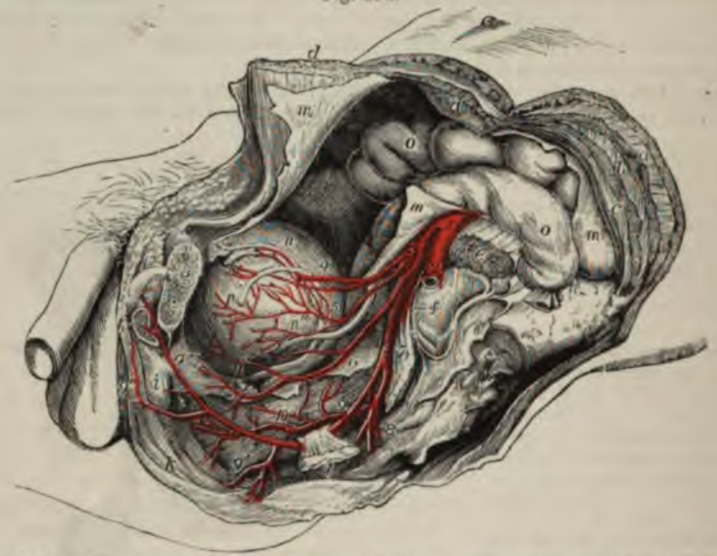


Fig. 272.—The arteries of the male pelvis, as seen on the removal of the left hip-bone, &c. (from R. Quain). ¼

*a*, external oblique muscle divided; *b*, internal oblique; *c*, transversalis; *d*, *d*, the parts of the divided rectus; *e*, psoas magnus divided; *f*, placed on the auricular surface of the sacrum, points to the sacral plexus of nerves; *g*, placed on the os pubis, sawn through a little to the left of the symphysis, points to the divided spermatic cord; *h*, crus penis divided; *i*, bulb of the urethra; *k*, external sphincter muscle; *l*, spine of the ischium with the small sacro-sciatic ligament; *m*, peritoneum; *n*, upper part of the urinary bladder; *n'*, *n'*, vas deferens; *n"*, ureter; *o*, *o*, intestines; 1, common iliac artery; 2, external iliac; 3, internal iliac; 4, obliterated hypogastric and superior vesical arteries; 5, middle vesical; 6, inferior vesical artery; 7, placed on the sacral plexus, points to the common trunk of the pudic and sciatic arteries; close above 7, the gluteal artery is seen cut short; 8, sciatic artery cut short; 9, placed on the rectum, the pudic artery as it is about to pass behind the spine of the ischium; 9', on the lower part of the rectum, the inferior hæmorrhoidal branches; 9", the superficial perineal artery; 9‴, placed on the prostate gland, the pudic artery in the fore part of the perineum, giving off the artery of the bulb, and finally dividing into the artery of the corpus cavernosum and the dorsal artery of the penis; 10, placed on the middle part of the rectum, the superior hæmorrhoidal artery.

and runs between the layers of that structure to near the apex of the subpubic arch. Close to the ramus of the pubis it perforates the inferior layer of the triangular ligament, and ends under cover of the crus penis by dividing into the artery of the corpus cavernosum and the dorsal artery of the penis. The pudic artery is accompanied throughout its course by the vein of the same name.

Within the pelvis, the pudic artery rests against the rectum internally, and the sacral plexus of nerves intervenes between it and the pyriformis muscle. Over the ischial spine, the artery is covered by the gluteus maximus muscle, and the pudic nerve lies to its inner side. In the ischio-rectal fossa, the artery is contained in the substance of the obturator fascia, the dorsal nerve of the penis being above, and the perineal branch of the pudic nerve below it; and between the layers of the triangular ligament, it is embedded, in company with the dorsal nerve of the penis, in the tendinous origin of the constrictor urethræ muscle.

*Branches.*—From the part of the artery within the pelvis small offsets proceed to the obturator internus, pyriformis, and coccygeus muscles. As the artery crosses the ischial spine it gives off branches to the adjacent part of the gluteus maximus, and other twigs which supply the external rotator muscles and anastomose with offsets of the sciatic artery. In the perineum the following larger branches arise:—

(*a*) The *inferior* or *external hæmorrhoidal artery*, often represented by two or three separate branches, arises from the pudic artery as it enters the perineal space. Directed inwards through the fat of the ischio-rectal fossa towards the anus, it divides into branches which supply the superficial structures of the posterior part of the perineum, the sphincter and levator ani muscles, and anastomose with the other hæmorrhoidal arteries as well as with the corresponding vessels of the opposite side. Small offsets also turn round the border of the gluteus maximus and supply the overlying integument, while others pass forwards and communicate with the superficial perineal artery.

(*b*) The *superficial perineal artery* (v) arises from the pudic at the fore part of the ischio-rectal fossa. Crossing over or under the transversus perinei muscle, it runs forwards beneath the superficial perineal fascia, in company with the nerves of the same name, gives offsets to the subjacent muscles, and divides into long slender branches which supply the back of the scrotum and anastomose with the external pudic branches of the femoral artery.

(*c*) The *transverse perineal artery* (vi) generally arises in common with the preceding, but it is sometimes a distinct branch of the pudic artery. Passing inwards towards the central point of the perineum, it supplies the parts between the anus and the bulb of the urethra, and anastomoses with its fellow of the opposite side.

(*d*) The *artery of the bulb* (v) arises from the pudic near the point where that vessel enters between the layers of the triangular ligament. It runs inwards between the fibres of the constrictor urethræ muscle, being placed usually about half an inch from the base of the triangular ligament, and penetrates the bulb to be distributed to the erectile tissue of the corpus spongiosum. It gives branches to Cowper's gland, and to the membranous part of the urethra.

Another smaller branch to the corpus spongiosum is frequently given off by the pudic artery near its bifurcation, or by the artery of the corpus cavernosum.

(*e*) The *artery of the corpus cavernosum* (art. profunda penis) (v) is slightly the larger of the two terminal branches of the pudic trunk. It penetrates the inner side of the crus penis, and is continued forwards in the centre of the corpus cavernosum to the anterior extremity of that body, giving off in its course numerous offsets to the erectile tissue.

Fig. 273.

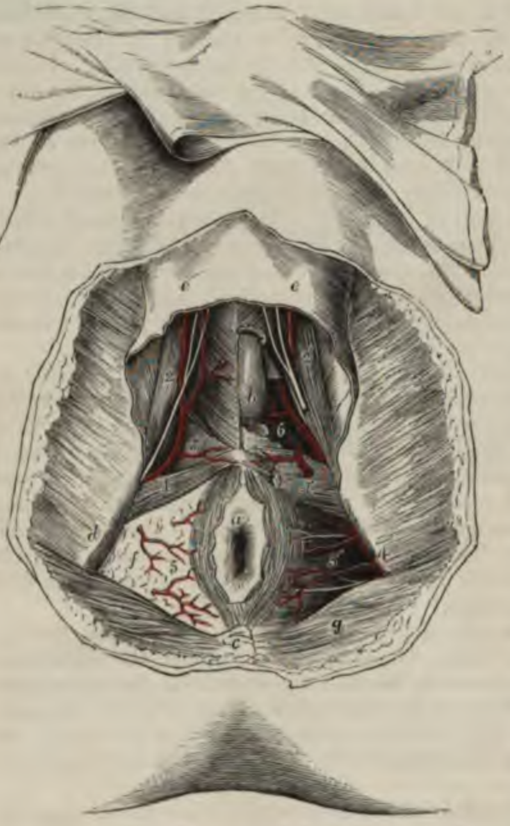


Fig. 273.—Dissection of the Perineum in the Male. (A. T.) $\frac{1}{2}$

This drawing is made from a preparation upon a modification of the plan of R. Quain's 61st and 62nd Plates. The right side shows a superficial, the left a deeper view.

*a*, anus, with a part of the integument surrounding it; *b*, left half of the bulb of the urethra, exposed by the removal of the bulbo-cavernosus muscle; *c*, coccyx; *d*, right tuberosity of the ischium; *e*, *e*, superficial perineal fascia; *f*, fat occupying the right ischio-rectal fossa; *g*, gluteus maximus muscle; 1, placed on the right transversus perinei muscle, points to the superficial perineal artery as it emerges in front (in this case) of the muscle; 1′, on the left side, placed on the surface of the triangular ligament, points to the superficial perineal artery cut short; 2, on the right ischio-cavernosus muscle, points to the superficial perineal artery and nerves passing forwards; 2′, on the left side, the same vessel and nerves divided; 3, on the right half of the triangular ligament, points to the transverse perineal artery; 4, on the left tuberosity of the ischium, points to the pudic artery deep in the ischio-rectal fossa; 5, 5′, inferior hæmorrhoidal branches of the pudic arteries and nerves; 6, on the left side, placed in a recess from which the inferior layer of the triangular ligament has been removed, in order to show the continuation of the pudic artery, its branch to the bulb, and one of Cowper's glands.

(*f*) The *dorsal artery of the penis* (v) ascends to the upper surface of that organ between the crus and the pubic symphysis. After piercing the suspensory ligament, the artery runs forwards, between the median dorsal vein and the corresponding nerve, to the neck of the penis, where it ends in offsets to the glans and the prepuce. It supplies the integument of the penis, and several branches pass through the fibrous sheath of the corpus cavernosum to the spongy tissue in its interior, and anastomose with the offsets of the deep artery. The right and left dorsal arteries communicate freely together in the glans penis.

**Varieties.**—The pudic artery is sometimes small, and fails to supply one or two, or even three of its usual branches, which, in those circumstances, are furnished by a supplemental vessel, the *accessory pudic.* The defect most frequently met with is that in which the pudic ends as the artery of the bulb, while the arteries of the corpus cavernosum and dorsum of the penis are derived from the accessory pudic. But all the three arteries of the penis may be supplied by the accessory pudic, the pudic itself ending as the superficial perineal. A single accessory pudic has been found to supply both cavernous arteries, while the pudic of the right side gave both dorsal arteries (R. Quain, pl. 63, fig. 5). On the other hand, cases have occurred in which only a single branch was furnished by the accessory artery, either to take the place of an ordinary branch altogether wanting, or to supplement one of the branches which was diminutive in size.

The *accessory pudic artery* generally arises from the pudic itself, before the passage of that vessel through the sacro-sciatic foramen, and descends within the pelvis, along the lower part of the urinary bladder and across the side of the prostate gland, to reach the root of the penis by perforating the triangular ligament in front of the membranous part of the urethra. Less frequently the accessory pudic is derived from the inferior vesical (p. 452), or from some other branch of the internal iliac artery. It may also arise from the obturator artery within the pelvis, that vessel taking origin either from the internal iliac or the epigastric artery, and in a few cases it has been given off by the epigastric artery directly.

*Branches.*—The *artery of the bulb* is sometimes small, sometimes wanting on one side, and occasionally it is double. But a more important deviation from the common condition is one sometimes met with, in which the vessel, arising earlier, and crossing the perineum farther back than usual, reaches the bulb from behind. In such a case there is considerable risk of dividing the artery in performing the lateral operation for stone. On the other hand, when this vessel arises from an accessory pudic artery, it lies farther forwards than usual, and is out of danger in case of operation.

The *dorsal artery of the penis* has been observed to arise from the obturator artery in the thyroid foramen, from one of the external pudic branches of the femoral, or from the deep femoral artery (Tiedemann, tab. 33, fig. 1). This branch is sometimes small on one side, the deficiency being supplied by the opposite artery. The two dorsal arteries are occasionally united by a cross branch, and they have been seen uniting into a common trunk on the dorsum of the penis.

The **pudic artery in the female.**—In the female this vessel is much smaller than in the male. It takes a similar course, but the following branches differ in their size and distribution from the corresponding arteries in the male.

The *superficial perineal artery* is larger than in the male, and is distributed to the labia pudendi.

The *artery of the bulb* is small, and supplies the bulb of the vestibule.

The two terminal branches are much smaller than in the male. The *artery of the corpus cavernosum* (art. profunda clitoridis) enters that body; and the *dorsal artery of the clitoris* passes forwards between the crura clitoridis and terminates in the glans and in the membranous fold corresponding to the prepuce of the male.

**7.** The **sciatic artery** (iv), the larger of the two terminal branches of the anterior division of the internal iliac, is distributed chiefly to the muscles on the back of the pelvis. It descends on the anterior surface of the pyriformis muscle and the sacral plexus of nerves, and issues by the lower part of the great sacro-sciatic foramen, in company with the pudic artery and the sciatic nerves. Continuing its course downwards, under cover of the gluteus maximus and resting upon the obturator internus and gemelli muscles, it ends as a slender vessel which accompanies the small sciatic nerve along the back of the thigh, supplying the integument and anastomosing with superficial branches of the perforating arteries.

*Branches.*—(*a*) *Muscular* branches pass to the lower part of the gluteus maximus, anastomosing in the muscle with the gluteal artery; to the external rotator muscles, anastomosing with twigs of the pudic artery; and to the muscles arising from the ischial tuberosity, anastomosing with the obturator and internal circumflex arteries.

Fig. 274.

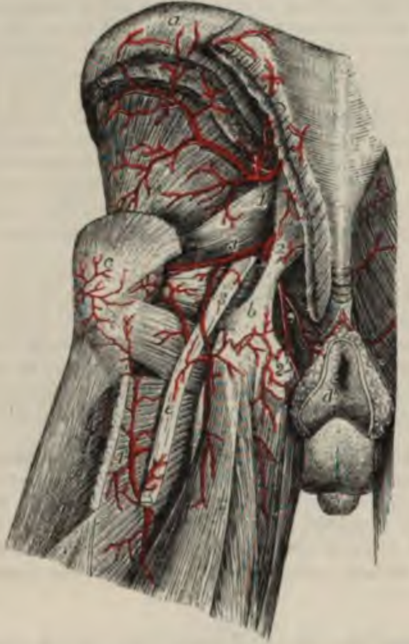


Fig. 274.—ARTERIES OF THE BACK OF THE PELVIS (from Tiedemann). ¼

*a*, crest of the ilium; *b*, tuberosity of the ischium; *c*, great trochanter; *d*, integument round the anus; *e*, great sciatic nerve; 1, trunk of the gluteal artery as it issues from the great sacro-sciatic foramen, the superficial part is cut short, the deep part is seen passing forwards on the surface of the gluteus minimus muscle; 2, placed on the great sacro-sciatic ligament, points to the pudic artery at the place where it winds over the spine of the ischium; 2′, the continuation of the artery in the perineum; 3, 3, sciatic artery; the upper figure points to the trunk of the vessel, from which the anastomotic branch is seen running outwards towards the great trochanter; the lower figure indicates the continuation of the artery along the back of the thigh; 4, first perforating artery.

(*b*) The *coccygeal* branch, inclining inwards, pierces the great sacro-sciatic ligament, and is distributed mainly to the gluteus maximus, two or three offsets perforating that muscle and ramifying in the subcutaneous tissue over the sacrum and coccyx.

(*c*) The *anastomotic* branch, directed outwards to the hollow on the inner side of the great trochanter, supplies the external rotator muscles and the hip-joint, and anastomoses with offsets of the gluteal artery, with the ascending branch of the internal circumflex artery, and with the first perforating artery.

(*d*) The *comes nervi ischiadici* (vi) enters the great sciatic nerve, which it supplies, and anastomoses with twigs of the perforating arteries.

(*e*) Several *cutaneous* branches pass to the integument at the lower border of the gluteus maximus, along with branches of the small sciatic nerve.

**Varieties.**—The sciatic artery occasionally arises in common with the gluteal, leaving that vessel outside the pelvis, at the upper border of the pyriformis muscle. In a few cases this artery has been found much enlarged, and forming the main artery of the limb (see varieties of the femoral artery). The *comes nervi ischiadici* has been seen by Hyrtl of large size, and continued along the thigh to join the popliteal artery, a little above the knee-joint (Wiener Denkschriften, xxiii., 1864).

**8.** The **gluteal artery** (iii), the largest branch of the internal iliac, is distributed to the muscles on the outer side of the pelvis. It passes backwards between the lumbo-sacral cord and the first sacral nerve, turns round the upper margin of the great sacro-sciatic foramen, and divides opposite the interval between the gluteus medius and pyriformis muscles into a superficial and a deep part. Before leaving the pelvis the gluteal artery gives some twigs to the pyriformis and obturator internus muscles, and one or two branches to the hip-bone.

(*a*) The *superficial* part, the smaller of the two divisions, passes backwards between the contiguous borders of the gluteus medius and pyriformis muscles, and divides into a number of branches, which are distributed to the gluteus maximus, and anastomose with the sciatic and the posterior branches of the lateral sacral arteries.

(*b*) The *deep* part divides again into two branches, which run forwards between the gluteus medius and minimus muscles. The *superior* branch courses along the upper border of the gluteus minimus towards the anterior superior iliac spine, and, after supplying the muscles between which it is placed, anastomoses with the ascending branch of the external circumflex artery, as well as with the deep circumflex iliac by means of branches which perforate the origin of the gluteus medius, and ascend over the iliac crest. The *inferior* branch crosses the middle of the gluteus minimus, distributes offsets to the smaller gluteal muscles and the hip-joint, and anastomoses with the external circumflex and sciatic arteries.

**Variety.**—One instance is recorded in which the gluteal artery was replaced by a large branch arising from the femoral and passing outwards and backwards to reach the gluteal muscles (F. T. Roberts, Liverpool Med. and Surg. Rep., 1867).

**9.** The **ilio-lumbar artery** (v) resembles in a great measure one of the lumbar arteries. It is a short vessel which passes outwards, between the obturator nerve and the lumbo-sacral cord, to the upper end of the ilio-pectineal line, where it divides, behind the inner margin of the psoas muscle, into lumbar and iliac branches.

The *lumbar* or *ascending* branch turns upwards under cover of the psoas, to which and to the quadratus lumborum it is mainly distributed, and anastomoses with the lower lumbar arteries. A *spinal* branch is sent inwards through the last intervertebral foramen, and is distributed like the spinal offsets of the lumbar arteries.

The *iliac* or *transverse* branch is directed outwards into the iliac fossa, and ramifies partly beneath, partly on the surface of the iliacus muscle, giving offsets to the bone, and forming anastomoses with the obturator, circumflex iliac, and lumbar arteries.

**Varieties.**—The ilio-lumbar artery frequently arises from the internal iliac above the division of that trunk; more rarely from the common iliac. The iliac and lumbar portions sometimes arise separately from the parent trunk.

**10.** The **lateral sacral arteries** (v) are usually two in number on each side, although occasionally they are united into one. They arise close together from the posterior division of the internal iliac. Both arteries incline somewhat inwards and descend on the front of the sacrum, internal to the anterior sacral foramina. The superior artery is confined to the upper part of the sacrum; the inferior passes downwards to the front of the coccyx, and terminates by anastomosing with offsets of the middle sacral artery.

From the lateral sacral arteries small offsets proceed outwards to the pyriformis and coccygeus muscles, and to the sacral nerves, anastomosing with one another round the foramina. Others are directed inwards and anastomose with branches of the middle sacral artery. The largest branches pass backwards into the anterior sacral foramina, supply twigs to the sacral canal, and are continued through the posterior foramina to the muscles and integuments on the back of the sacrum, anastomosing with the gluteal and sciatic arteries.

### EXTERNAL ILIAC ARTERY.

The external or anterior of the two arteries resulting from the division of the common iliac forms a large continuous trunk, which extends downwards in the limb as far as the lower border of the popliteus muscle, but, for convenience of description, it is named in successive parts of its course external iliac, femoral, and popliteal.

Fig. 275.

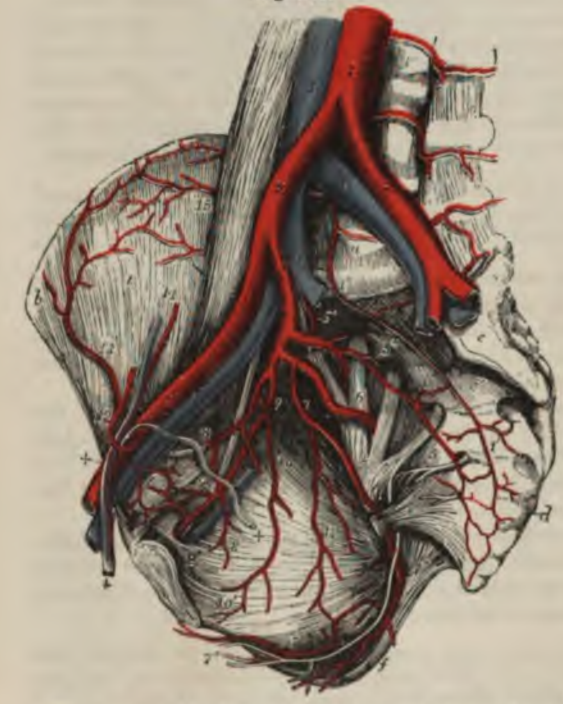


Fig. 275.—THE ILIAC ARTERIES OF THE RIGHT SIDE, IN THE MALE. (A. T.) $\frac{1}{3}$

For the detailed description of this figure, see p. 449. 2', external iliac artery, accompanied by 4', the corresponding vein; 12, epigastric artery, winding to the inner side of +, +, the spermatic cord, and sending downwards its pubic branch to join 9', the pubic offsets of the obturator artery; the epigastric artery is cut short superiorly; 13, circumflex iliac artery, anastomosing with 15, branches of the ilio-lumbar; 14, spermatic vessels, descending to join the spermatic cord; +, within the pelvis, the vas deferens descending from the cord.

The external iliac artery (9-10 mm.) is placed within the abdomen, and extends from the bifurcation of the common iliac to the lower border of Poupart's ligament, where the vessel enters the thigh, and is named femoral. It is larger than the internal iliac, and measures usually from three and a half to four inches in length. Inclining obliquely outwards, its course, together with that of the common iliac artery, may be marked by a line drawn on the surface of the abdomen from the place of division of the aorta, *i.e.*, a spot about a finger's breadth to the left of and below the umbilicus, to a point midway between the anterior superior spine of the ilium and the symphysis pubis. The upper third of this line would lie over the common iliac, the lower two-thirds over the external iliac artery.

Fig. 276.

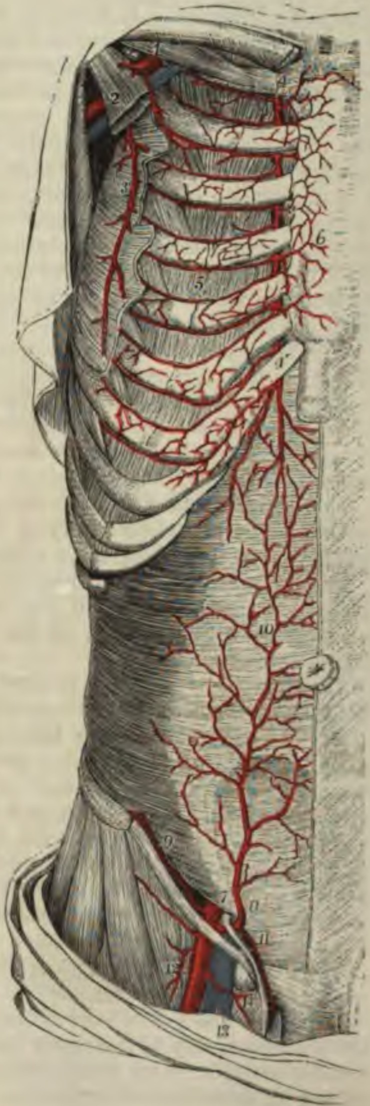


Fig. 276.—The distribution and anastomoses of the epigastric and internal mammary arteries (from Tiedemann). $\frac{1}{4}$

For the detailed description of this figure, see p. 399. 7, on the transversalis muscle above the internal abdominal ring, points to the last part of the external iliac artery, at the place where it gives origin to 8, the epigastric, and 9, the circumflex iliac artery; 10, anastomosis of the epigastric with the abdominal branch of the internal mammary artery; 11, spermatic cord, receiving the cremasteric branch from the epigastric artery; 12, femoral artery; 13, femoral vein; 14, a lymphatic gland closing the crural ring.

In its course downwards and forwards, the external iliac artery is situated a little above the brim of the pelvis, and rests for the most part against the inner border of the psoas, but near Poupart's ligament it passes on to the front of that muscle. It is, however, separated from the muscle by the iliac fascia, to which it is bound, together with the companion vein, by the subperitoneal tissue. The artery is covered by peritoneum, and crossed on the left side by the sigmoid flexure of the colon, on the right by the termination of the ileum. The ureter, as it descends into the pelvis, sometimes passes over the upper end of the vessel.

*Relation to veins, &c.*—The *external iliac vein* lies at first behind the artery with an inclination to the inner side; but, as the vessels approach Poupart's ligament at the fore part of the pelvis, the vein is on the same plane with the artery and quite to the inner side, being carried forwards by the bone. At a short distance from its lower end the artery is crossed by the *circumflex iliac vein.*

Large *lymphatic glands* are found resting upon the front and inner side of the artery; and the *spermatic* (or *ovarian*) *vessels*, together with the *genital branch of the genito-crural nerve*, descend over it near its termination.

BRANCHES.—The external iliac artery supplies small twigs to the psoas muscle and the neighbouring lymphatic glands, and, close to its termination, two branches of considerable size, viz., the epigastric and the circumflex iliac, which are distributed to the walls of the abdomen.

**1.** The **deep epigastric artery** (**iv**) (inferior epigastric) arises from the inner and fore part of the external iliac, usually a few lines above Poupart's ligament. It is at first directed inwards for a short distance between Poupart's ligament and the internal abdominal ring, and then ascends on the inner side of that aperture, being covered by the transversalis fascia and resting on the peritoneum. As it turns round the internal abdominal ring, the artery is crossed on its outer side, in the male by the vas deferens and the spermatic vessels, which here meet to form the spermatic cord, in the female by the round ligament of the uterus. Continuing its course upwards, the vessel perforates the transversalis fascia and passes over the semilunar fold of Douglas to enter the sheath of the rectus, becoming closely applied to the back of that muscle. It finally divides, somewhat above the level of the umbilicus, into a number of branches which supply the rectus, and anastomose freely in the muscle with the abdominal branch of the internal mammary artery.

The epigastric artery is accompanied by two veins, which unite into a single trunk before ending in the external iliac vein.

BRANCHES.—These are small but numerous.

(*a*) The *cremasteric artery* (vi) descends on the spermatic cord, and, besides supplying the cremaster muscle and other coverings of the cord, anastomoses with the spermatic and external pudic arteries.

(*b*) The *pubic* branch (vi) ramifies behind the pubis, and communicates with the corresponding artery of the opposite side, as well as with the pubic branch of the obturator artery.

(*c*) *Muscular* branches, which arise mainly from the outer side of the epigastric artery, ramify in the broad muscles of the abdomen, and anastomose with branches of the circumflex iliac, lumbar, and lower intercostal arteries.

(*d*) *Superficial* branches perforate the rectus muscle, and anastomose beneath the skin with branches of the superficial epigastric artery.

**2.** The **deep circumflex iliac artery** (**v**) arises from the outer side of the external iliac, generally a little below the origin of the epigastric artery. It runs upwards and outwards behind Poupart's ligament, resting on the iliacus muscle, and being contained in a fibrous canal at the junction of the transversalis and iliac fasciæ, as far as the anterior superior iliac spine. From this point the artery is continued backwards along the inner margin of the iliac crest, giving branches to the iliacus and lateral abdominal muscles, and ends by anastomosing with the iliac branch of the ilio-lumbar artery. Some small branches also pierce the muscles attached to the crest of the ilium and communicate with offsets of the gluteal artery.

From the first part of the circumflex iliac artery branches are given to the ilio-psoas, and to the upper ends of the sartorius and tensor vaginæ femoris muscles. One considerable branch, sometimes replaced however by two or three smaller ones, arises near the anterior superior spine, and ascends between the internal oblique and transversalis muscles, supplying the abdominal wall, and anastomosing with the epigastric and lumbar arteries.

Two veins accompany the circumflex iliac artery; these unite below into a single vessel, which crosses the external iliac artery about three quarters of an inch above Poupart's ligament, and joins the external iliac vein.

**Varieties.**—*Size.*—In those rare cases in which the principal vessel of the lower limb is continued from the sciatic branch of the internal iliac artery, the external iliac is much diminished in size, and ends in the profunda artery of the thigh.

*Branches.*—The usual *number* of two principal branches of the external iliac artery may be increased by the separation of the circumflex iliac into two branches, or by the addition of a branch usually derived from another source, such as the internal circumflex artery of the thigh, or the obturator artery, or very rarely the deep femoral artery.

The *deep epigastric artery* occasionally arises higher than usual, as at an inch and a half, or even two inches and a half, above Poupart's ligament; and it has been seen to arise below that ligament from the femoral, or from the deep femoral artery. The epigastric frequently furnishes the obturator artery as already described (p. 454), and a few examples are recorded in which the epigastric artery arose from an obturator furnished by the internal iliac artery. In a single instance the epigastric artery was represented by two branches, one arising from the external iliac, and the other from the internal iliac artery (Lauth, in Velpeau's "Médecine Opératoire," v. ii., p. 452). Some combinations of the epigastric with the internal circumflex, or with the circumflex iliac, or with both those vessels, have been noticed.

The *deep circumflex iliac artery* sometimes deviates from its ordinary position, —arising at a distance not exceeding an inch above Poupart's ligament. Deviations in the opposite direction are not so frequent, but it is occasionally found arising below the ligament, from the femoral artery.

### SURGICAL ANATOMY OF THE EXTERNAL ILIAC ARTERY.

The external iliac artery is usually tied about midway between its commencement and the origin of the epigastric artery. It may be exposed by a curved incision, about four inches in length, commencing about an inch above and a little outside the middle of Poupart's ligament, and terminating about an inch above the anterior superior iliac spine. After dividing carefully the integument, the abdominal muscles, and transversalis fascia, the peritoneum (to which the spermatic vessels adhere) is raised from the iliac fossa, and the artery is found at the margin of the pelvis, lying along the inner border of the psoas muscle. The vein is close to the artery, on its posterior and inner aspect. In order to pass the ligature, it is necessary to divide the layer of subperitoneal tissue which binds the vessel down to the iliac fascia.

*Collateral circulation.*—After ligature of the external iliac artery, blood is conveyed to the lower end of that vessel through the anastomoses of the epigastric with the internal mammary, intercostal, and lumbar arteries, and of the circumflex iliac with the lumbar and ilio-lumbar arteries; to the femoral trunk also by the anastomoses of the branches of the deep femoral artery with the branches of the internal iliac, viz., the internal circumflex with the obturator and sciatic arteries, the external circumflex with the gluteal, and the perforating arteries with the sciatic.

## FEMORAL ARTERY.

The femoral artery is that portion of the artery of the lower limb which lies in the upper three-fourths of the thigh,—its limits being marked above by Poupart's ligament, and below by the opening in the great adductor muscle, after passing through which the artery receives the name of popliteal.

Fig. 277.

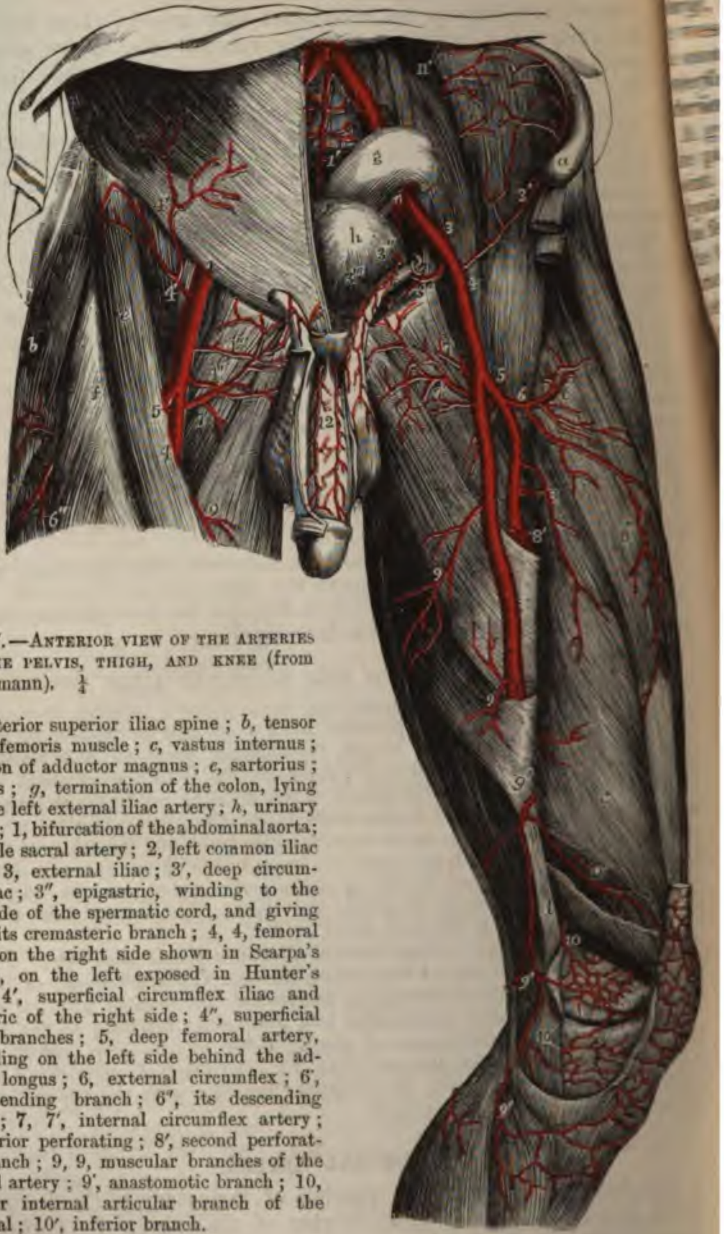


Fig. 277.—ANTERIOR VIEW OF THE ARTERIES OF THE PELVIS, THIGH, AND KNEE (from Tiedemann). $\frac{1}{4}$

*a*, anterior superior iliac spine ; *b*, tensor vaginæ femoris muscle ; *c*, vastus internus ; *d*, tendon of adductor magnus ; *e*, sartorius ; *f*, rectus ; *g*, termination of the colon, lying upon the left external iliac artery ; *h*, urinary bladder ; 1, bifurcation of the abdominal aorta; 1′, middle sacral artery ; 2, left common iliac artery ; 3, external iliac ; 3′, deep circumflex iliac ; 3″, epigastric, winding to the inner side of the spermatic cord, and giving off 3‴, its cremasteric branch ; 4, 4, femoral artery, on the right side shown in Scarpa's triangle, on the left exposed in Hunter's canal ; 4′, superficial circumflex iliac and epigastric of the right side ; 4″, superficial pudic branches ; 5, deep femoral artery, descending on the left side behind the adductor longus ; 6, external circumflex ; 6′, its ascending branch ; 6″, its descending branch ; 7, 7′, internal circumflex artery ; 8, superior perforating ; 8′, second perforating branch ; 9, 9, muscular branches of the femoral artery ; 9′, anastomotic branch ; 10, superior internal articular branch of the popliteal ; 10′, inferior branch.

At its commencement the femoral artery is of the same size as the external iliac from which it is prolonged (9-10 mm.), but at a distance of from one to two inches below Poupart's ligament it becomes suddenly smaller (i) in consequence of its giving off a large branch, *deep femoral artery*, for the supply of the muscles of the thigh. The short portion of the vessel above the origin of its deep branch is frequently referred to as the *common femoral artery*, which is then described as dividing into the *superficial femoral* (the continuation of the trunk) and the *deep femoral arteries*.

A general indication of the direction of the femoral artery, over the fore part and inner side of the thigh, is given by a line reaching from a point midway between the anterior superior iliac spine and the symphysis pubis above to the prominent tuberosity on the inner condyle of the femur below, the hip-joint having been first somewhat flexed, and the thigh abducted and rotated out. In the first part of its course the artery lies along the middle of the depression known as Scarpa's triangle, between the ilio-psoas muscle on the outer side, and the adductor muscles on the inner side of the limb. In this situation the beating of the artery may be felt, and the circulation through the vessel may be most easily controlled by pressure. At a distance of from three to four inches below Poupart's ligament, the sartorius muscle, which forms the outer boundary of Scarpa's triangle, inclining inwards, comes to lie over the artery, and conceals the vessel in the remainder of its extent. Beneath the sartorius the artery is contained, together with the femoral vein and the internal saphenous nerve, in an elongated intermuscular space which is called Hunter's canal, and which is bounded externally by the vastus internus muscle, internally and posteriorly by the adductors.

While passing through Scarpa's space, the femoral artery is covered only by the integument and the iliac portion of the fascia lata, as well as, in its upper part, by the crural sheath which invests both the artery and the vein. In the rest of its course it is covered by the sartorius muscle, and also by a dense fibrous membrane which stretches across from the tendons of the long and great adductors to the vastus internus muscle, and forms the anterior wall of Hunter's canal. The artery rests at first upon the psoas muscle, by which it is separated from the margin of the pelvis and the capsule of the hip-joint ; next it is placed in front of the pectineus and adductor brevis muscles, the companion vein and deep femoral vessels being interposed ; afterwards, it lies upon the long adductor muscle ; and lastly, upon the tendon of the great adductor, the femoral vein being placed between the tendon and the artery. In the lower half of its course, it has immediately on its outer side the vastus internus muscle, which intervenes between it and the internal surface of the femur.

At the groin the artery, after having passed over the margin of the pelvis, is placed in front of the innermost part of the head of the femur ; and at its lower end, the vessel lies close to the inner side of the shaft of the bone ; but in the intervening space, in consequence of the projection of the neck and shaft of the femur outwards, while the artery holds a straight course, it is separated from the bone by a considerable interval.

*Relation to veins.*—The *femoral vein* is very close to the artery, both being enclosed in the same sheath, and separated from each other only by a thin partition of fibrous membrane. At the groin, the vein lies on the same plane as the artery, and to its inner side ; but gradually inclining backwards, the vein is placed behind the artery at the lower end of Scarpa's space, and afterwards gets somewhat to the outer side.

The *deep femoral vein*, near its termination, crosses behind the femoral artery; and the *internal saphenous vein*, as it ascends on the fore part of the limb, lies to the inner side; but it not unfrequently happens that a superficial vein of considerable size ascends for some distance directly over the artery.

*Relation to nerves.*—At the groin, the *anterior crural nerve* lies a little to the outer side of the femoral artery (about a quarter of an inch), being separated from the vessel by some fibres of the psoas muscle and by the iliac fascia. Lower down in the thigh, the *internal saphenous nerve* accompanies the artery in Hunter's canal, lying along its anterior surface, until the vessel perforates the adductor magnus. The *internal cutaneous nerve* also crosses the upper part of the artery at the inner border of the sartorius.

Fig. 278.

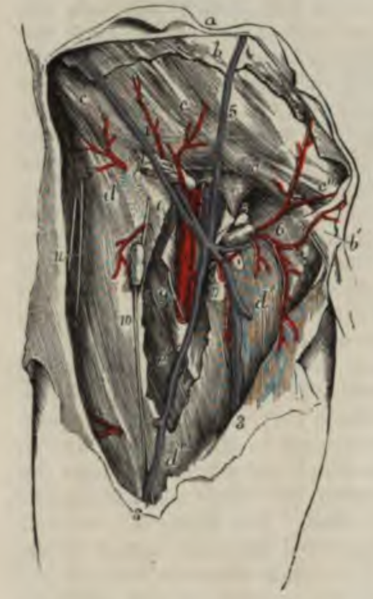


Fig. 278.—DISSECTION OF THE RIGHT GROIN, SHOWING THE FEMORAL VESSELS AND THEIR SUPERFICIAL BRANCHES. (R. Quain.) $\frac{1}{4}$

*a*, integument of the abdomen; *b*, superficial abdominal fascia; *b′*, the part descending on the spermatic cord; *c*, *c*, aponeurosis of the external oblique muscle; *c′*, the same near the external abdominal ring; *c″*, inner pillar of the ring; *d*, iliac part of the fascia lata; *d′*, pubic part; *e*, *e*, crural sheath laid open, the inner letter is immediately over the crural canal; *e′*, sartorius muscle, partially exposed; 1, femoral artery, having 2, the femoral vein to its inner side; the septum of the sheath is shown between the two vessels; 3, internal saphenous vein; 3′, its anterior branch; 4, superficial circumflex iliac vein and arterial branches to the glands of the groin; 5, superficial epigastric vein; 6, external pudic vessels; 7 to 8, some of the lower inguinal glands receiving twigs from the vessels; 9, internal, 10, middle, and 11, external cutaneous nerves.

BRANCHES.—The femoral artery gives off the following branches:—some small and superficial, which are distributed to the integument and glands of the groin and ramify on the lower part of the abdomen, viz., the external pudic (superior and inferior), the superficial epigastric, and the superficial circumflex iliac; the great nutrient artery of the muscles of the thigh, named the deep femoral or profunda; several muscular branches; and lastly, the anastomotic artery, which descends to the inner side of the knee.

**1** and **2**. The **external pudic arteries** arise either separately or by a common trunk from the inner side of the femoral artery. The *superior*, the more superficial branch, perforates the cribriform fascia in the saphenous opening, and courses upwards and inwards, passing in the male over the spermatic cord, to be distributed to the integument on the lower part of the abdomen and on the external organs of generation. The *inferior* branch, more deeply seated, runs inwards on the surface of the pectineus and adductor longus muscles (occasionally beneath the latter), to both of which it furnishes branches, and, piercing the fascia lata at the inner border of the thigh, is distributed to the scrotum in the male, to the labium in the female. The external pudic arteries anastomose with each other, with the superficial perineal artery, and with the cremasteric branch of the deep epigastric artery.

Fig. 279.

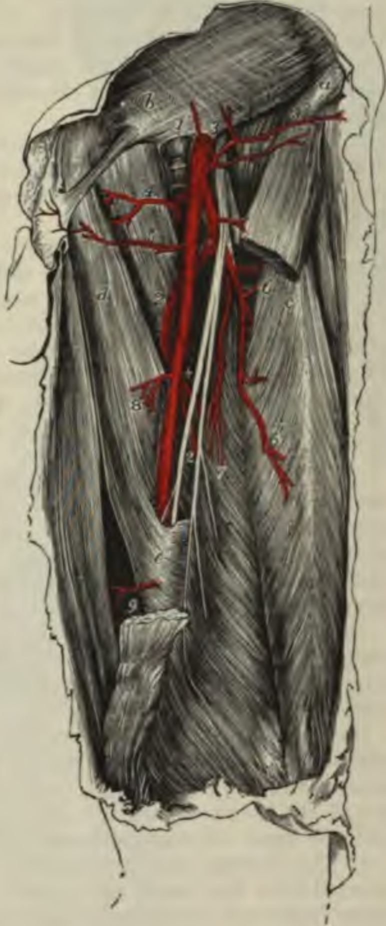


Fig. 279.—THE FEMORAL ARTERY AND ITS BRANCHES (from R. Quain). ¼

The sartorius muscle has been removed in part, so as to expose the artery in the middle third of the thigh: *a*, anterior superior iliac spine; *b*, aponeurosis of the external oblique muscle near the external abdominal ring; *c*, rectus femoris muscle; *d*, adductor longus; *e*, lower part of the aponeurosis covering the artery; 1, 1, femoral artery; 1′, femoral vein, divided and tied close below Poupart's ligament; 2, 2, 2, deep femoral artery; 3, anterior crural nerve, the figure lies between two superficial epigastric branches of the artery; 3′, superficial circumflex iliac artery; 4, 5, external pudic arteries, the deeper arising in this case from the internal circumflex; 6, external circumflex artery, with its ascending, transverse and descending branches separating from it; 6′, branch to the rectus muscle; 7, branch to the vastus internus muscle; 8 and 9, some of the muscular branches of the femoral; +, origin of the second perforating artery.

**3**. The **superficial epigastric artery**, arising from the femoral about half an inch below Poupart's ligament, passes forwards through the fascia lata (sometimes through the upper part of the saphenous opening) and runs upwards on the abdomen in the superficial fascia covering the external oblique muscle. Its branches, ascending nearly as high as the umbilicus, anastomose with superficial branches of the deep epigastric artery.

**4**. The **superficial circumflex iliac artery,** frequently arising in common with the superficial epigastric, runs outwards across the iliacus muscle, in the direction of Poupart's ligament, towards the iliac crest. It gives small twigs to the iliacus and sartorius muscles, anastomosing with the deep circumflex iliac artery, and other branches which perforate the fascia lata and supply the integument of the hip.

All the preceding arteries give small branches to the lymphatic glands in the groin.

**5.** The **deep femoral** or **profunda artery (ii),** the principal nutrient vessel of the thigh, usually arises from the outer and back part of the femoral, about an inch and a half below Poupart's ligament. It is directed at first somewhat outwards, in front of the iliacus muscle, so as to be visible for a short distance external to the continuation of the femoral trunk; then inclining inwards and slightly backwards, it descends behind that vessel, and between the adductor longus and magnus muscles near their femoral attachments. Giving off numerous branches on its way downwards, the profunda diminishes rapidly in size; and it terminates, at the junction of the middle and lower thirds of the thigh, as a small vessel which pierces the adductor magnus, and is known as the lowest perforating artery.

This artery lies successively in front of the iliacus, pectineus, adductor brevis, and adductor magnus muscles. The femoral and profunda veins and the adductor longus muscle are interposed between it and the femoral trunk.

*Branches.*—The named branches of the deep femoral artery are the external and internal circumflex, and the perforating arteries. Other less regular offsets pass to the vastus internus, and to the adductor muscles.

1. The *external circumflex artery* (iii-iv), the largest of the branches, arises from the outer side of the profunda near its commencement. Passing outwards for a short distance beneath the sartorius and rectus muscles, and between the divisions of the anterior crural nerve, it gives offsets to the neighbouring muscles, and ends by dividing into the three following branches:—

(*a*) The *ascending* branch runs upwards beneath the tensor vaginæ femoris, supplies that muscle and the fore parts of the gluteus medius and minimus, and anastomoses with the terminal branches of the gluteal artery, as well as with offsets of the deep circumflex iliac. One branch passes up under cover of the rectus muscle, and is distributed to the hip-joint.

(*b*) The *transverse* branch, the smallest of the three, is directed outwards over the crureus, and divides into two or three branches which enter the vastus externus muscle on its deep surface, and anastomose with the upper perforating arteries.

(*c*) The *descending* branch, much larger than the others, sends its offsets downwards to the rectus, vastus externus and crureus muscles, anastomosing in the last with the inferior perforating arteries. One or two of the lowest branches reach as far as the knee, and communicate with the upper external articular of the popliteal.

2. The *internal circumflex artery* (iv), arising generally opposite the external from the inner and posterior part of the deep femoral artery, passes backwards between the psoas and pectineus muscles, and over the upper border of the adductor brevis, towards the small trochanter of the femur, close to which it divides into two terminal branches, *ascending* and *transverse.* It furnishes *muscular* branches, which supply the obturator externus and adductor muscles, and anastomose with the obturator artery, and an *articular* branch (developed in inverse proportion to the articular branch of the obturator artery) which enters the hip-joint through the cotyloid notch, and supplies the fat and synovial membrane in the interior.

(*a*) The *ascending* branch follows the tendon of the obturator externus muscle to the hollow on the inner side of the great trochanter, where it supplies the external rotator muscles, and anastomoses with offsets of the gluteal, sciatic, and first perforating arteries.

Fig. 280.

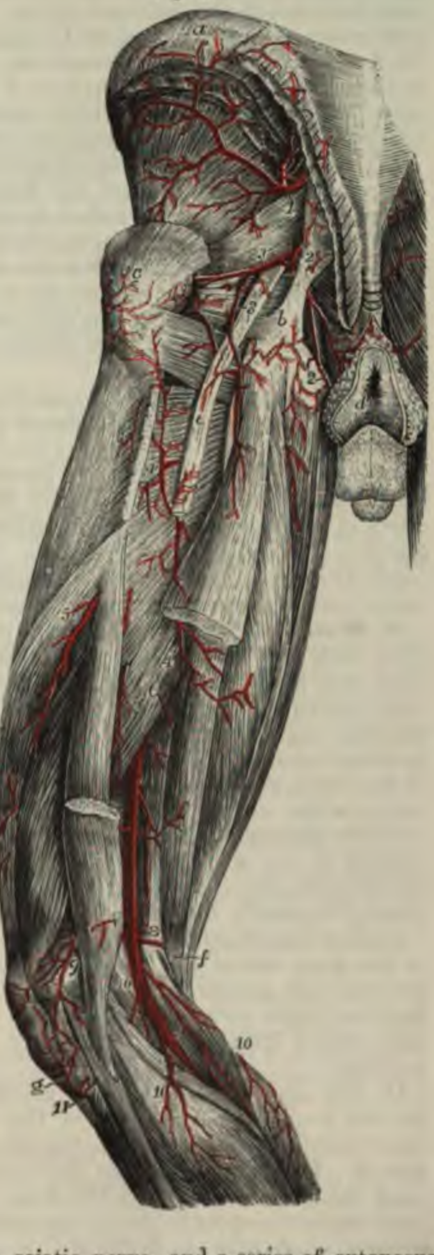


Fig. 280.—Posterior view of the arteries of the pelvis, thigh, and popliteal space (from Tiedemann). ¼

*a*, iliac crest; *b*, attachment of the great sacro-sciatic ligament to the tuberosity of the ischium; *c*, great trochanter; *d*, integument around the anus; *e*, great sciatic nerve; *f*, semitendinosus and semimembranosus muscles; *g*, head of the fibula; 1, gluteal artery; 2, pudic; 3, sciatic; 4, first perforating artery; 4′, its branches to the hamstring muscles; 5, 6, branches of the lower perforating arteries; 7, 7, popliteal artery, near the upper figure the origin of the superior muscular branches; 8, placed on the tendon of the adductor magnus, near the origin of the superior articular branches; 9, the anastomosis of the external superior articular with other branches; 10, 10, sural branches; 11, anterior tibial recurrent artery.

(*b*) The *transverse* branch, larger than the foregoing, passes backwards between the quadratus femoris and adductor magnus muscles, and is distributed to the upper parts of the hamstring muscles, anastomosing with the sciatic and first perforating arteries.

3. The *perforating arteries* are subject to considerable variation in their arrangement, but they are generally four in number, including the terminal branch of the parent vessel. They pass backwards close to the femur, through small tendinous arches in the insertion of the adductor magnus muscle, and give considerable branches to the hamstring muscles, as well as small twigs to the great sciatic nerve, and a series of cutaneous

branches, which issue along the back of the external intermuscular septum and supply the integument on the outer and posterior aspects of the thigh. All these offsets anastomose with one another, the upper ones also with the sciatic and internal circumflex arteries, and the lower ones with branches of the popliteal artery. Much diminished in size, the perforating arteries are continued outwards, winding round the back of the femur, the first passing through the insertion of the gluteus maximus and the others through the short head of the biceps and the external intermuscular septum, to terminate in the vastus externus and crureus muscles, where they anastomose with branches of the external circumflex artery.

(*a*) The *first perforating artery* passes backwards at the lower border of the pectineus muscle, through the fibres of the adductor brevis and adductor magnus, to both of which it furnishes branches, and is distributed mainly to the hamstring muscles and the lower end of the gluteus maximus. One branch ascends beneath the latter muscle on the back of the femur, and joins in the anastomosis in the hollow internal to the great trochanter with the gluteal, sciatic and internal circumflex arteries. Only a very small vessel is continued through the gluteus maximus into the vastus externus muscle.

(*b*) The *second perforating artery* is frequently united at its origin with the first, a little below which it pierces the adductor brevis and magnus muscles.

(*c*) The *third perforating artery* pierces the adductor magnus muscle below the insertion of the adductor brevis. The principal *medullary artery* of the femur is derived from either the second or third perforating artery.

(*d*) The *fourth perforating artery* supplies chiefly the short head of the biceps muscle. It frequently gives a second artery to the femur.

**6. Muscular branches.**—In Scarpa's triangle the femoral artery gives some small branches to the surrounding muscles. In Hunter's canal a variable number of larger branches is given off to the sartorius, vastus internus, and adductor muscles. A constant branch, of considerable size, arises from the femoral artery near its termination (sometimes from the beginning of the popliteal) and passes outwards close to the back of the femur, perforating the short head of the biceps and the external intermuscular septum, to end in the outer part of the crureus muscle.

**7.** The **anastomotic artery** (**iv**) arises from the femoral close to the opening in the adductor magnus muscle, and immediately divides into two branches, superficial and deep, which are, however, not unfrequently given off separately from the femoral trunk.

(*a*) The *superficial* branch accompanies the internal saphenous nerve to the inner side of the knee, giving offsets to the lower parts of the sartorius and gracilis muscles, and ends by supplying the skin of the upper and inner part of the leg. Small twigs anastomose over the inner tuberosity of the tibia with the lower internal articular artery of the popliteal.

(*b*) The *deep* branch descends, embedded in the fibres of the vastus internus muscle, along the front of the adductor magnus tendon to the inner condyle of the femur, where it anastomoses with the internal articular arteries. It supplies the vastus internus and crureus muscles, and sends small offsets outwards across the front of the femur, as well as one of larger size at the upper border of the patella, to join the superior external articular artery from the popliteal.

magnus to the lower border of the popliteus muscle, where it divides into the anterior and posterior tibial arteries. Its termination is on a level with the lower part of the tubercle of the tibia.

In the first part of its course the popliteal artery inclines slightly from within outwards, over the inner portion of the popliteal surface of the femur, to reach a point behind the middle of the knee-joint, whence it descends vertically to its lower end. Being deeply situated in its whole extent, it is covered at its upper end by the semimembranosus muscle; for a short distance above the knee it is placed in the popliteal space; below this it is covered by the gastrocnemius muscle and is also crossed by the plantaris; and its termination is beneath the upper margin of the soleus muscle.

At its commencement the artery lies close to the inner side of the femur, but in descending it is separated by an interval from the somewhat hollowed popliteal surface of the bone; it then rests on the posterior ligament of the knee-joint, and lastly on the popliteus muscle.

*Relation to veins.*—The *popliteal vein* lies close to the artery throughout. At the upper end it is placed to the outer side and somewhat behind, it then gradually crosses over the artery, and below gains the inner side. The vein is frequently double along the lower part of the artery, and more rarely also at the upper part. The *short saphenous vein*, ascending to join the popliteal, is also placed over the artery in the lower part of the popliteal space.

*Relation to the nerve.*—The *internal popliteal nerve* lies at first to the outer side of, but much nearer to the surface than, the artery; it afterwards crosses gradually over the vessels, and is placed behind and to the inner side of them below the joint. The nerve is separated from the artery throughout its course by the vein.

BRANCHES.—The branches of the popliteal artery may be arranged in two sets, viz., the muscular and the articular.

A. The muscular branches are divided into a superior and an inferior group.

1. The **superior muscular** branches, three or four in number, are distributed to the lower parts of the adductor magnus and hamstring muscles, and anastomose with the perforating and upper articular arteries. Small offsets pass from these branches to the internal popliteal nerve and to the skin, and also communicate above with the branches of the perforating arteries.

2. The **inferior muscular** or **sural arteries**, generally two in number, and of considerable size, arise from the back of the popliteal artery, a little above the knee-joint, and enter, one the outer, and the other the inner head of the gastrocnemius muscle, which they supply, as well as the plantaris and the upper part of the soleus muscle.

Over the surface of the gastrocnemius, on each side and in the middle of the limb, are slender branches, which descend a considerable distance along the calf of the leg and supply the integument. These small vessels (*superficial sural*) may arise either from the popliteal trunk or from its sural branches.

B. The articular arteries are five in number. Two of these pass off nearly at right angles from the popliteal artery, one on each side, above the condyles of the femur; two others have a similar arrangement below the knee-joint; and the fifth passes directly forwards into the centre of the joint.

or one of the circumflex arteries, arising at a higher level than usual must, however, be borne in mind in considering the propriety of applying a ligature to this part of the vessel.

In performing the operation, an incision about two and a half inches in length, with its centre placed over the artery, is made parallel to and half an inch below Poupart's ligament, dividing the integument and the iliac portion of the fascia lata. Any superficial arteries that have been cut being secured, the crural sheath is then laid open, and the artery freed from its areolar investment. The vein is here to the inner side of the artery, and, being separated from that vessel by a septum in the crural sheath, does not come into view. The needle should be passed from within outwards.

The *superficial femoral artery* may be tied either immediately below Scarpa's triangle, or in Hunter's canal. The former position is that usually preferred by surgeons, owing to the superficial position of the vessel, and its freedom from large branches. The hip having been slightly flexed, and the thigh everted, an incision about three and a half inches long, and so placed that its centre is about four and a half inches from Poupart's ligament, is made in the line of the artery (p. 467). The integument and fascia lata are cut through at once, and the sartorius muscle exposed. The inner border of the sartorius is then raised and drawn well outwards, together with the internal cutaneous nerve which lies along this edge of the muscle (fig. 278), and the sheath of the artery is opened in the centre of the incision and separated from the vessel. The femoral vein is not seen, as it is placed behind the artery, only a very thin layer of connective tissue being interposed between the two. The needle is to be passed from within outwards, its point being kept close to the artery. A considerable branch of the saphenous vein may be divided in making the first incision, and if so will require a ligature.

To reach the artery in Hunter's canal a longer incision is necessary, in consequence of the greater depth of the vessel, and it should be made a finger's breadth internal to the line of the artery, care being taken to avoid the internal saphenous vein. The superficial structures and the fascia lata having been cut through, the sartorius muscle is exposed and is recognized by its fibres running parallel to the line of the incision. The outer border of this muscle is then freed and drawn inwards, when the aponeurosis covering the femoral vessels is laid bare, and is to be carefully divided. The sheath of the artery is now opened, avoiding the internal saphenous nerve which lies on the surface of the vessel, and the needle is to be passed from without inwards, as the vein is placed behind and slightly to the outer side of the artery.

*Collateral circulation.*—When the common femoral artery has been tied, the circulation in the lower limb is carried on by means of the anastomoses of the internal pudic artery with the pudic branches of the femoral, of the obturator with the internal circumflex, of the circumflex iliac and gluteal with the external circumflex, and of the sciatic with the internal circumflex and upper perforating branches of the profunda. After ligature of the superficial femoral artery, blood reaches the distal portion of the limb through the anastomoses of the descending branch of the external circumflex artery with the articular arteries of the knee, and through the communications along the back of the thigh, between the sciatic artery, the terminal branches of the internal circumflex, the perforating arteries and the branches of the popliteal. In several instances in which the condition of the vessels has been examined after ligature of the femoral (or external iliac) artery, the comes nervi ischiadici has been found much enlarged, forming, with anastomotic branches from the perforating arteries, a vessel which accompanies the great sciatic nerve, and ends below in the popliteal artery or one of its branches.

## POPLITEAL ARTERY (I—II).

The popliteal artery, continuous with the femoral, is placed at the back of the knee, and extends along the lower fourth of the thigh and the upper sixth of the leg. It reaches from the opening in the adductor magnus to the lower border of the popliteus muscle, where it divides into the anterior and posterior tibial arteries. Its termination is on a level with the lower part of the tubercle of the tibia.

In the first part of its course the popliteal artery inclines slightly from within outwards, over the inner portion of the popliteal surface of the femur, to reach a point behind the middle of the knee-joint, whence it descends vertically to its lower end. Being deeply situated in its whole extent, it is covered at its upper end by the semimembranosus muscle; for a short distance above the knee it is placed in the popliteal space; below this it is covered by the gastrocnemius muscle and is also crossed by the plantaris; and its termination is beneath the upper margin of the soleus muscle.

At its commencement the artery lies close to the inner side of the femur, but in descending it is separated by an interval from the somewhat hollowed popliteal surface of the bone; it then rests on the posterior ligament of the knee-joint, and lastly on the popliteus muscle.

*Relation to veins.*—The *popliteal vein* lies close to the artery throughout. At the upper end it is placed to the outer side and somewhat behind, it then gradually crosses over the artery, and below gains the inner side. The vein is frequently double along the lower part of the artery, and more rarely also at the upper part. The *short saphenous vein*, ascending to join the popliteal, is also placed over the artery in the lower part of the popliteal space.

*Relation to the nerve.*—The *internal popliteal nerve* lies at first to the outer side of, but much nearer to the surface than, the artery; it afterwards crosses gradually over the vessels, and is placed behind and to the inner side of them below the joint. The nerve is separated from the artery throughout its course by the vein.

BRANCHES.—The branches of the popliteal artery may be arranged in two sets, viz., the muscular and the articular.

A. The muscular branches are divided into a superior and an inferior group.

**1.** The **superior muscular** branches, three or four in number, are distributed to the lower parts of the adductor magnus and hamstring muscles, and anastomose with the perforating and upper articular arteries. Small offsets pass from these branches to the internal popliteal nerve and to the skin, and also communicate above with the branches of the perforating arteries.

**2.** The **inferior muscular** or **sural arteries**, generally two in number, and of considerable size, arise from the back of the popliteal artery, a little above the knee-joint, and enter, one the outer, and the other the inner head of the gastrocnemius muscle, which they supply, as well as the plantaris and the upper part of the soleus muscle.

Over the surface of the gastrocnemius, on each side and in the middle of the limb, are slender branches, which descend a considerable distance along the calf of the leg and supply the integument. These small vessels (*superficial sural*) may arise either from the popliteal trunk or from its sural branches.

B. The articular arteries are five in number. Two of these pass off nearly at right angles from the popliteal artery, one on each side, above the condyles of the femur; two others have a similar arrangement below the knee-joint; and the fifth passes directly forwards into the centre of the joint.

**1.** The **superior internal articular artery** is directed inwards just above the inner head of the gastrocnemius, and beneath the inner hamstring muscles, to all of which it furnishes small offsets. Winding round the inner side of the femur, between the bone and the tendon of the adductor magnus, it divides under cover of the vastus internus muscle into branches, which anastomose with the deep part of the anastomotic, the upper external articular, and the lower articular arteries. The size of this artery varies inversely with that of the deep part of the anastomotic branch of the femoral.

Fig. 281.

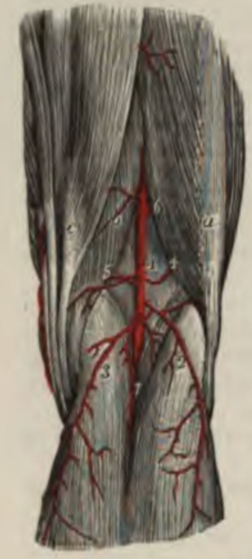


Fig. 281.—VIEW OF THE POPLITEAL ARTERY AND ITS BRANCHES IN THE RIGHT LEG (from Tiedemann). ¼

*a*, biceps muscle; *b*, semimembranosus; *c*, semitendinosus; 1, popliteal artery; 2, 3, superficial sural branches; 4, outer; 5, inner superior articular branch; 6, superior muscular; 7, median superficial artery.

**2.** The **superior external articular artery (v)**, larger than the internal, runs outwards above the outer head of the gastrocnemius, under cover of the biceps, and, perforating the intermuscular septum, enters the lower part of the crureus muscle. Its branches anastomose above with the descending branch of the external circumflex artery, below with the lower external articular artery, and internally with the upper internal articular artery and the deep branch of the anastomotic, forming with the last a considerable arch at the upper border of the patella.

**3.** The **inferior internal articular artery (v)**, the larger of the two lower branches, inclines at first downwards and inwards along the upper margin of the popliteus muscle, to which it gives branches, and then passes forwards below the inner tuberosity of the tibia, between the internal lateral ligament and the bone. Its offsets ramify over the inner and fore part of the joint, as far as the patella and its ligament, and anastomose with the superficial branch of the anastomotic, the upper internal articular, and lower external articular arteries.

**4.** The **inferior external articular artery** takes its course outwards, under cover of the outer head of the gastrocnemius in the first instance, and afterwards beneath the external lateral ligament of the knee and the tendon of the biceps muscle, resting against the margin of the external semilunar fibro-cartilage. Having reached the fore part of the joint, it divides near the patella into branches, some of which communicate with the lower internal articular artery and with the recurrent branch from the anterior tibial, while others anastomose with the upper articular arteries.

**5.** The **middle** or **azygos articular artery** is a small branch which arises opposite the flexure of the joint, and pierces the posterior ligament to be distributed to the crucial ligaments and other structures within the articulation. Small twigs also pass forwards in the mucous ligament to the fat at the front of the joint, and communicate with the other articular arteries.

The upper and lower articular arteries of the popliteal, the anastomotic branch of the femoral, and the anterior tibial recurrent artery form, by their communications over the front of the knee, a superficial wide-meshed network of fine vessels between the fascia and skin, and a deeper and closer network of larger vessels, in contact with the bones, from which numerous offsets proceed to the interior of the joint.

Fig. 282.

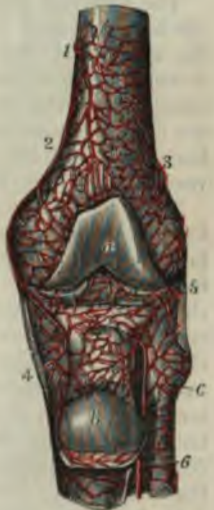


Fig. 282.—THE DEEP ANASTOMOSES OF THE FRONT OF THE KNEE (from Tiedemann). ¼

*a*, patellar surface of the femur ; *b*, posterior surface of the patella which, with the ligamentum patellæ, has been turned down ; *c*, head of the fibula ; 1 and 2, branches of the anastomotic and superior internal articular arteries, ramifying on the bone and anastomosing with the superior external articular branch 3, and with other arteries within and below the joint ; 4, branches of the internal inferior articular ; 5, external inferior articular ; 6, anterior tibial recurrent artery.

**Varieties.**—Deviations from the ordinary condition of the popliteal artery are not frequent. The principal departure from the ordinary arrangement consists in the high division of the vessel into its terminal branches. Such an early division has been found to take place opposite the knee joint, or in the intercondylar fossa of the femur, but not higher. In one case, observed by Portal, the artery was continued down to the middle of the leg before dividing.

The popliteal artery has been seen occasionally dividing into anterior tibial and peroneal arteries—the posterior tibial being small or absent. In a single case, the popliteal artery was found by R. Quain dividing into three terminal branches, viz., the anterior and posterior tibial and the peroneal arteries.

One instance is recorded in which the popliteal artery passed downwards internal to the origin of the inner head of the gastrocnemius muscle, and then turned outwards between that and the internal condyle of the femur, to gain the popliteal space (T. P. A. Stuart, Journ. Anat., xiii., 162). In two or three cases the positions of the artery and vein have been found reversed. The artery is occasionally separated from the vein by an accessory slip of origin of the gastrocnemius muscle (p. 254).

The *azygos articular* branch often arises from one of the other articular arteries, especially the superior external branch. There are sometimes several small middle articular branches. Two examples of a *small saphenous artery*, formed by the enlargement of the median superficial sural branch, and descending with the short saphenous nerve and vein to the back of the external malleolus, have been met with.

### SURGICAL ANATOMY OF THE POPLITEAL ARTERY.

The popliteal artery is very rarely tied, since, in cases of aneurism of the arteries of the upper part of the leg, ligature of the superficial femoral artery is both an easier and a more successful operation. The artery might, however, if necessary, be secured either in its upper or its lower part, but in the middle portion of its extent, while contained within the popliteal space, the artery is closely covered by the vein and nerve, as well as by the sural branches of the vessels and the external saphenous vein ; and moreover the principal branches are also arising here, so that a ligature cannot be safely applied to this part of the vessel. In its upper part the artery may be reached either by making an incision on the inner side of the thigh in its lower third, and then separating the sartorius and inner hamstring muscles from the tendon of the adductor magnus, or by dividing the integument in the middle line of the limb posteriorly, and then turning inwards the semimembranosus muscle. In an operation upon the lower part of the artery, the incision would have to be carried between the heads of the gastrocnemius muscle, care being taken to avoid the external saphenous vein.

### POSTERIOR TIBIAL ARTERY (III).

The posterior tibial artery, the larger of the two vessels resulting from the bifurcation of the popliteal, lies along the back of the leg, between the superficial and deep muscles of this part, being closely bound down to those of the latter group by the fascia which covers them. It extends from the lower border of the popliteus muscle to the lower border of the internal annular ligament, where it divides, on a level with a line drawn from the point of the internal malleolus to the centre of the convexity of the heel (Wyeth), into the internal and external plantar arteries.

Situated at its origin opposite the interval between the tibia and fibula, the artery approaches the inner side of the leg as it descends, and lies behind the tibia ; at its lower end it is placed midway between the inner malleolus and the prominence of the heel. Very deeply seated at the upper part, where it is covered by the fleshy portions of the gastrocnemius and soleus muscles, it becomes superficial in the lower third of the leg, being there covered only by the integument and two layers of fascia, and by the annular ligament behind the inner malleolus. At its termination the artery is placed beneath the origin of the abductor hallucis muscle. It lies successively upon the tibialis posticus, the flexor longus digitorum, and, at its lower end, directly on the tibia and the ankle-joint. Behind the ankle, the tendons of the tibialis posticus and flexor longus digitorum lie between the artery and the internal malleolus ; while the tendon of the flexor longus hallucis is to its outer side.

*Relation to the veins and nerve.*—The posterior tibial artery is accompanied by two *venæ comites*. The *posterior tibial nerve* is at first on the inner side of the artery, but as soon as the latter has given off its peroneal branch, the nerve crosses over the vessel and is continued down on its outer side. Beneath the internal annular ligament the artery is frequently placed between the *internal* and *external plantar* divisions of the posterior tibial nerve.

BRANCHES.—The posterior tibial artery gives off one large branch—the peroneal artery, and numerous small offsets which will be first described.

**1.** Several **muscular** branches are distributed to the deep-seated muscles, and one or two of considerable size to the inner part of the soleus muscle. A small offset from one of these perforates the tibial attachment of the soleus, and ascends over the popliteus muscle to anastomose with the lower internal articular artery.

**2.** The **medullary artery** of the tibia, the largest of its kind in the body, arises from the posterior tibial near its commencement, and, after giving small branches to the neighbouring muscles, enters the foramen in the bone. This vessel not unfrequently arises from the anterior tibial artery.

**3.** Two or three **cutaneous** branches, of small size, supply the skin of the inner side of the leg.

**4.** A **communicating** branch passes transversely, beneath the flexor longus hallucis muscle, between the posterior tibial and peroneal arteries, about an inch above the ankle-joint. A second loop of communication between these vessels is sometimes present, lying in the fat beneath the tendo Achillis.

Fig. 283.

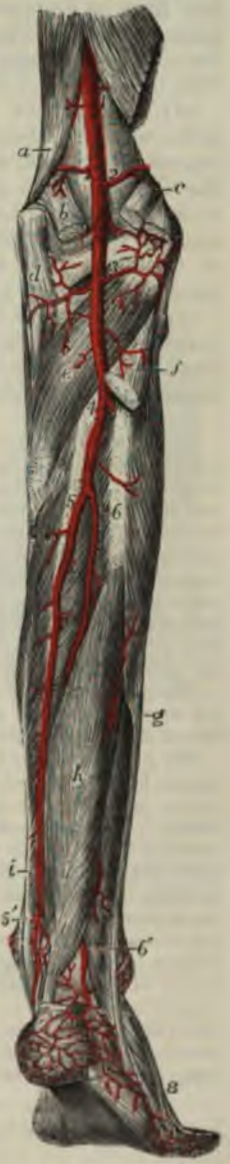


Fig. 283.—DEEP VIEW OF THE ARTERIES OF THE BACK OF THE RIGHT LEG (from Tiedemann). ¼

*a*, lower part of the adductor magnus muscle; *b*, origin of the inner head of the gastrocnemius; *c*, outer head and plantaris; *d*, tendon of the semimembranosus muscle; *e*, popliteus; *f*, fibular origin of the soleus; *g*, peroneus longus; *h*, flexor longus hallucis; *i*, flexor longus digitorum; 1, upper part of the popliteal artery; 2, origin of the superior articular branches; 3, origin of the inferior articular branches; the middle or azygos branch is seen between these numbers; 4, division of the popliteal artery into anterior and posterior tibial arteries; 5, 5′, posterior tibial; at 5′, the internal malleolar branches are seen passing inwards, and the communicating branch outwards; 6, peroneal artery; 6′, its continuation as posterior peroneal; 7, calcaneal branches; 8, external branches of the metatarsal of the dorsal artery of the foot.

**5.** One or two small **internal malleolar** branches pass inwards beneath the flexor longus digitorum and tibialis posticus muscles, and ramify over the internal malleolus, where they anastomose with similar offsets from the anterior tibial artery.

**6.** The **peroneal artery (iv)** lies deeply along the back part of the leg, close to the fibula. Arising from the posterior tibial artery about an inch below the lower border of the popliteus muscle, it inclines at first slightly outwards towards the fibula, being covered by the soleus and the deep layer of fascia, and resting upon the tibialis posticus muscle; it then descends vertically along the inner border of the bone and under cover of the flexor longus hallucis, being contained in a fibrous canal between the origins of that muscle and the tibialis posticus. Opposite the lower end of the interosseous space it gives off the anterior peroneal branch, and is thence continued downwards, being much reduced in size and taking the name of *posterior peroneal artery*, over the lower tibio-fibular articulation and behind the external malleolus, to terminate in branches which ramify on the outer surface and back of the os calcis. The peroneal artery is accompanied by two *venæ comites*, and, until it enters the flexor longus hallucis, by the branch of the posterior tibial nerve to that muscle.

*Branches*—(*a*) *Muscular* branches pass from the peroneal artery to the soleus, tibialis posticus, flexor longus hallucis, and peronei muscles.

Small branches also perforate the interosseous membrane, and are distributed to the extensor longus digitorum and peroneus tertius muscles (Hyrtl).

(*b*) A *medullary artery* enters the fibula.

(*c*) The *communicating* branch, lying close behind the tibia about an inch from its lower end, is a branch of variable size, which connects the peroneal and posterior tibial arteries, and also sends small twigs beneath the muscles to ramify over the inner side of the lower part of the tibia. This branch is sometimes wanting.

(*d*) The *anterior peroneal artery* (v), arising from an inch to an inch and a half above the ankle joint, passes forwards below the interosseous membrane, and descends in front of the articulation between the tibia and fibula to the outer side of the tarsus. It communicates with the external malleolar branch of the anterior tibial artery, and supplies offsets to the peroneus tertius muscle, and the articulations of the ankle; its terminal branches anastomose with the posterior peroneal and tarsal arteries.

(*e*) The *terminal* branches of the posterior peroneal artery (*external calcaneal*) anastomose with the external malleolar and tarsal arteries on the outer side of the foot; and over the heel with the internal calcaneal branches of the external plantar artery.

**Varieties.**—The *posterior tibial artery*, as well as the anterior tibial, is lengthened in those instances in which the popliteal artery divides higher up than usual. Not unfrequently the posterior tibial artery is diminished in size, and is subsequently reinforced, either by a transverse branch from the peroneal in the lower part of the leg, or, more rarely, by two transverse vessels, one crossing close to the bone, and the other over the deep muscles. In other instances the posterior tibial may exist only as a short muscular trunk in the upper part of the leg, or may be entirely wanting, while an enlarged peroneal artery takes its place from above the ankle downwards into the foot. One or two *internal calcaneal* branches are frequently given off from the lower end of the posterior tibial artery.

The posterior tibial artery is occasionally covered in the lower third of the leg by muscle, which may be an accessory long flexor of the toes (p. 258), or a slip of the soleus (p. 255).

The *peroneal artery* has been found to arise lower down than usual, about three inches below the popliteus muscle; and, on the contrary, it sometimes arises higher up from the posterior tibial, or even from the end of the popliteal artery. In some cases of high division of the popliteal artery, the peroneal artery is transferred to the anterior tibial. It more frequently exceeds than falls short of the ordinary dimensions, being enlarged to reinforce the posterior tibial. In those rare instances in which it is lost before reaching the lower part of the leg, a branch of the posterior tibial takes its place. Absence of the peroneal artery has been recorded by Otto and W. Krause, but these cases are explained by Barkow, as being correctly suppression of the posterior tibial artery between the origin of the peroneal and the communicating branch. The *anterior peroneal* branch is sometimes enlarged to compensate for the small size of the anterior tibial artery in the lower part of the leg, or to supply the place of that artery on the dorsum of the foot; or it may be absent and be replaced by the external malleolar branch of the anterior tibial.

## PLANTAR ARTERIES.

The internal and external plantar arteries are the branches into which the posterior tibial divides, immediately below the internal annular ligament, where it is covered by the origin of the abductor hallucis muscle.

The **internal plantar artery** (**v**), much smaller than the external, lies along the inner side of the foot. Placed at first under cover of the abductor hallucis, it passes forwards in the groove between that muscle and the short flexor of the toes, and on reaching the head of the first metatarsal bone, considerably diminished in size, it terminates by joining the digital artery to the inner side of the great toe.

Fig. 284.

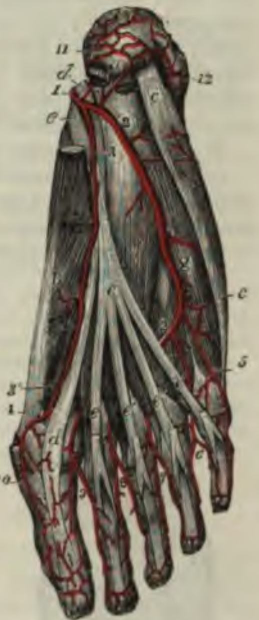


Fig. 284.—SUPERFICIAL VIEW OF THE ARTERIES IN THE SOLE OF THE RIGHT FOOT (from Tiedemann). $\frac{1}{3}$

*a*, tuberosity of the calcaneum close to the origins of the flexor brevis digitorum (cut short) and the abductor hallucis, of which a part is removed to show the plantar arteries; *b*, abductor hallucis; *c*, abductor minimi digiti; *d*, tendon of the flexor longus hallucis; *e*, tendon of the flexor longus digitorum; *e′*, its four slips, close to the lumbricales muscles, passing on to perforate the tendons of the flexor brevis; *f*, flexor accessorius; *g*, flexor brevis minimi digiti; 1, posterior tibial, dividing into the plantar arteries; 2, 2′, external plantar; 3, internal plantar; 3′, the same passing forwards to communicate with 4, the digital branch for the great toe, derived from the dorsal artery of the foot; 5, first digital branch to the fifth toe; 6, placed in the angle of division of the second digital artery, between the fourth and fifth toes; 7, third digital artery dividing similarly between the third and fourth toes; 8, fourth digital artery dividing between the second and third toes; 9, digital artery dividing between the first and second toes; 10, internal digital artery of the great toe; 11, calcaneal branches of the external plantar artery, anastomosing with 12, the calcaneal branches of the posterior peroneal artery.

*Branches*.—(*a*) Small branches of this artery accompany the digital branches of the internal plantar nerve, and join the digital arteries in the inner three clefts (see Ellis, "Illustrations of Dissections," pl. lvi.). It also gives (*b*) offsets to the surrounding muscles, and (*c*) cutaneous branches, which appear in the furrow between the middle and internal portions of the plantar fascia. (*d*) Other branches pass inwards and appear at the upper border of the abductor hallucis muscle, supplying the integument and anastomosing with offsets of the dorsal artery of the foot; and (*e*) from the outer side one or more branches run deeply into the foot, to supply the articulations and anastomose with branches of the plantar arch.

The **external plantar artery** (**iv**) at first inclines outwards and forwards, to reach the base of the fifth metatarsal bone; it then turns obliquely inwards across the sole, to gain the interval between the bases of the first and second metatarsal bones, where it joins the dorsal artery of the foot; and thus is completed the *plantar arch*, the convexity of which is turned forwards. At first the artery is placed, together with the external plantar nerve, between the calcaneum and the abductor hallucis; farther on it lies between the flexor brevis digitorum and flexor accessorius. As it turns forwards it lies in the interval between the short flexor of the toes and the abductor of the little toe, being placed along the line separating the middle from the external portion of the plantar fascia, and covered by that membrane. The remainder of the artery, which turns inwards and forms the plantar arch, is placed deeply against the interosseous muscles, and is covered by the flexors of the toes, the lumbricales muscles, and the adductor hallucis.

*Branches.*—A. *In its course to the fifth metatarsal bone,* the external plantar artery gives off (*a*) two or three *internal calcaneal* branches, which pierce the origin of the abductor hallucis muscle and ramify over the heel, anastomosing with the external calcaneal branches of the peroneal artery; (*b*) numerous *muscular* branches; (*c*) small offsets which ascend over the outer border of the foot and anastomose with the tarsal and metatarsal branches of the dorsal artery; and (*d*) *cutaneous* offsets, which appear in the groove between the middle and outer divisions of the plantar fascia.

B. *From the plantar arch* are given off the following branches:—

(*a*) From the concavity of the arch small offsets pass backwards to the articulations of the tarsus, and anastomose with the deep branches of the internal plantar artery.

(*b*) The *posterior perforating* branches, three in number, pass upwards through the back part of the three outer intermetatarsal spaces, between the heads of the dorsal interosseous muscles, and on reaching the dorsum of the foot inosculate with the interosseous branches of the metatarsal artery.

Fig. 285.

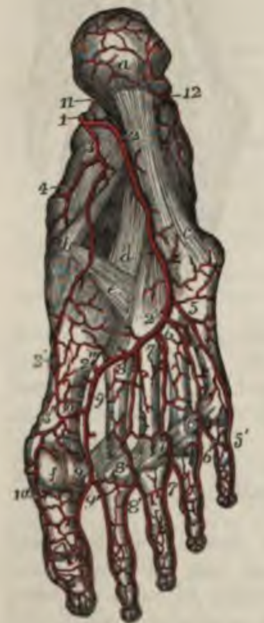


Fig. 285.—Deep view of the arteries in the sole of the right foot (from Tiedemann). ⅓

All the muscles have been removed: *a*, calcaneal tuberosity; *b*, internal cuneiform bone; *a*, to *c*, long, and *d*, short plantar ligament; *e*, prolongation of the tibialis posticus tendon; *f*, one of the sesamoid bones of the great toe; 1, posterior tibial artery dividing into the plantar arteries; 2, 2′, external plantar artery; 2′, 2″, plantar arch; 3, 3′, internal plantar artery; 3″, its communication with the internal digital artery of the great toe; 4, branches of the internal plantar to the inner side of the foot; 5, 5′, first digital branch; 6, second digital artery; 6′, its division between the fourth and fifth toes; 7, third digital artery; 7′, its distribution to the third and fourth toes; 8, fourth digital artery; 8′, its distribution to the second and third toes; 9, fifth digital artery; 9′, its distribution to the first and second toes; 10, internal digital branch of the great toe; at the upper numbers, 6, 7, and 8, the posterior perforating branches are partially seen; at 2″, the dorsal artery of the foot (in this instance of small size) is seen joining the plantar arch; 11, and 12, calcaneal branches of the external plantar and posterior peroneal arteries.

(*c*) The *digital* branches (v) are four in number. The *first* digital artery inclines outwards from the outermost part of the plantar arch, over the fifth metatarsal bone, and runs along the outer border of the little toe. The *second* digital artery passes forwards along the fourth intermetatarsal space, and near the cleft of the popliteal artery. It runs outwards across the neck of the fibula, perforating the attachment of the soleus, and is distributed to that muscle, to the peroneus longus, and to the integument.

3. The **anterior tibial recurrent artery** (v), larger than the posterior, arises from the trunk immediately after its passage through the aperture in the interosseous membrane. Ascending through the upper end of the tibialis anticus muscle, to which it furnishes offsets, this branch ramifies over the outer tuberosity of the tibia, and anastomoses with the lower articular arteries of the popliteal.

4. The **muscular** branches supply the muscles of the front of the leg, and send also three or four small twigs backwards through the interosseous membrane into the tibialis posticus (Hyrtl), as well as other offsets forwards between the muscles to the skin.

5. The **external malleolar artery** (v-vi), arises near the ankle-joint, and is directed outwards beneath the extensor longus digitorum and peroneus tertius muscles, to ramify over the outer malleolus, forming anastomoses with the anterior peroneal and tarsal arteries. It furnishes twigs to the neighbouring articulations.

6. The **internal malleolar artery**, smaller than the foregoing, passes inwards beneath the tendon of the tibialis anticus, and ramifies over the internal malleolus, anastomosing with the corresponding branches from the posterior tibial artery.

### DORSAL ARTERY OF THE FOOT (IV-V).

The dorsal artery of the foot, the continuation of the anterior tibial, extends from the bend of the ankle to the posterior end of the first intermetatarsal space. At this spot it turns downwards and passes between the heads of the first dorsal interosseous muscle into the sole, where it completes the plantar arch and supplies the inner side of the second and both sides of the great toes.

On the dorsum of the foot the artery lies in the interval between the tendons of the extensor proprius hallucis and extensor longus digitorum muscles, resting upon the tarsal bones, to which it is bound by an aponeurotic layer. It is covered by the integument and the dorsal fascia of the foot, at its upper end also by the lower band of the anterior annular ligament, and near its termination by the innermost slip of the extensor brevis digitorum muscle.

Two *venæ comites* accompany this artery, and the internal branch of the *anterior tibial nerve* lies usually on its outer side.

Branches.—On the dorsum of the foot, the artery gives off two or three small internal branches, which ramify on the inner side of the tarsus, and anastomose with branches of the internal plantar artery; two external branches, which are of larger size, and are named tarsal and metatarsal arteries; and the first dorsal interosseous artery, which arises as the trunk bends downwards in the first space. As soon as it appears in the sole, the artery divides into two terminal offsets, an outer communicating branch which completes the plantar arch, and an inner digital artery to the great and second toes.

1. The **tarsal artery** (v) arises opposite the head of the astragalus, and inclines outwards beneath the extensor brevis digitorum muscle to the cuboid bone, where it divides into branches which anastomose with

it gradually from the outer to the inner side. Above the ankle it is placed also beneath the upper band of the anterior annular ligament.

Fig. 286.

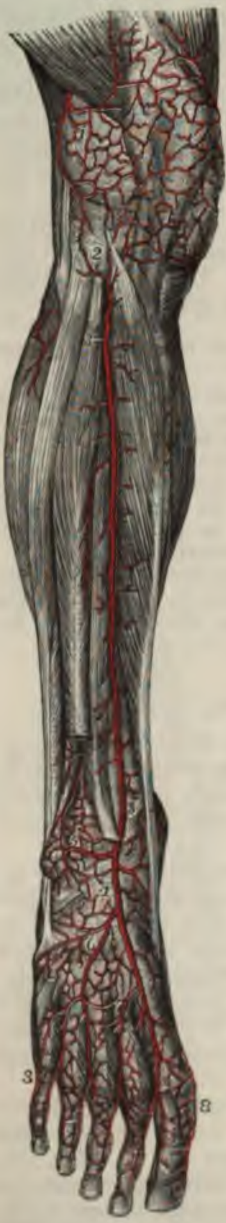


FIG. 286.—ANTERIOR VIEW OF THE ARTERIES OF THE LEG AND FOOT (from Tiedemann). ¼

The tibialis anticus muscle is drawn inwards so as to bring the anterior tibial artery into view; the extensor proprius hallucis, the long extensor of the toes and the peroneus tertius muscles in their lower part, and the whole of the extensor brevis, have been removed. 1, superior external articular branch of the popliteal artery, ramifying over the knee, and anastomosing with the other articular branches and with 2, the anterior tibial recurrent artery; 3, 3, anterior tibial, giving off muscular branches on each side; 4, dorsal artery of the foot; 5, external malleolar artery, anastomosing with the anterior peroneal which is seen descending upon the lower part of the fibula; the internal malleolar is represented proceeding from the inner side of the anterior tibial artery; 6, tarsal branch of the dorsal artery, in this instance larger than usual and reinforcing the next artery; 7, metatarsal branch, giving off the second dorsal interosseous artery; in the first interosseous space the dorsal artery of the foot is seen descending into the sole after having given off the first dorsal interosseous artery; between 8, and 8, the collateral dorsal digital arteries.

*Relation to veins and nerves.*—The anterior tibial artery is accompanied by two *venæ comites*. The *anterior tibial nerve*, coming from the outer side of the neck of the fibula, approaches the artery a short distance below the place where the vessel appears in front of the interosseous membrane. Lower down, the nerve for the most part lies in front of the artery, and at the ankle it is generally on the outer side of the vessel.

BRANCHES.—Before perforating the interosseous membrane the anterior tibial artery gives off the posterior tibial recurrent and the superior fibular branches. On the front of the leg it gives off the anterior tibial recurrent, numerous muscular branches, and the external and internal malleolar arteries.

**1.** The **posterior tibial recurrent artery** is a small branch which ascends beneath the popliteus muscle to the back of the knee-joint. It gives offsets to the popliteus and the upper tibio-fibular articulation, and anastomoses with the lower articular arteries from the popliteal. This branch is sometimes wanting.

**2.** The **superior fibular** branch (C. Krause), also of small size, arises most frequently from the anterior tibial artery, but it is sometimes derived from the posterior tibial, or from the lower end of the popliteal artery. It runs outwards across the neck of the fibula, perforating the attachment of the soleus, and is distributed to that muscle, to the peroneus longus, and to the integument.

3. The **anterior tibial recurrent artery** (v), larger than the posterior, arises from the trunk immediately after its passage through the aperture in the interosseous membrane. Ascending through the upper end of the tibialis anticus muscle, to which it furnishes offsets, this branch ramifies over the outer tuberosity of the tibia, and anastomoses with the lower articular arteries of the popliteal.

4. The **muscular** branches supply the muscles of the front of the leg, and send also three or four small twigs backwards through the interosseous membrane into the tibialis posticus (Hyrtl), as well as other offsets forwards between the muscles to the skin.

5. The **external malleolar artery** (v-vi), arises near the ankle-joint, and is directed outwards beneath the extensor longus digitorum and peroneus tertius muscles, to ramify over the outer malleolus, forming anastomoses with the anterior peroneal and tarsal arteries. It furnishes twigs to the neighbouring articulations.

6. The **internal malleolar artery**, smaller than the foregoing, passes inwards beneath the tendon of the tibialis anticus, and ramifies over the internal malleolus, anastomosing with the corresponding branches from the posterior tibial artery.

## DORSAL ARTERY OF THE FOOT (IV-V).

The dorsal artery of the foot, the continuation of the anterior tibial, extends from the bend of the ankle to the posterior end of the first intermetatarsal space. At this spot it turns downwards and passes between the heads of the first dorsal interosseous muscle into the sole, where it completes the plantar arch and supplies the inner side of the second and both sides of the great toes.

On the dorsum of the foot the artery lies in the interval between the tendons of the extensor proprius hallucis and extensor longus digitorum muscles, resting upon the tarsal bones, to which it is bound by an aponeurotic layer. It is covered by the integument and the dorsal fascia of the foot, at its upper end also by the lower band of the anterior annular ligament, and near its termination by the innermost slip of the extensor brevis digitorum muscle.

Two *venæ comites* accompany this artery, and the internal branch of the *anterior tibial nerve* lies usually on its outer side.

BRANCHES.—On the dorsum of the foot, the artery gives off two or three small internal branches, which ramify on the inner side of the tarsus, and anastomose with branches of the internal plantar artery; two external branches, which are of larger size, and are named tarsal and metatarsal arteries; and the first dorsal interosseous artery, which arises as the trunk bends downwards in the first space. As soon as it appears in the sole, the artery divides into two terminal offsets, an outer communicating branch which completes the plantar arch, and an inner digital artery to the great and second toes.

1. The **tarsal artery** (v) arises opposite the head of the astragalus, and inclines outwards beneath the extensor brevis digitorum muscle to the cuboid bone, where it divides into branches which anastomose with

the external malleolar, the peroneal, external plantar, and metatarsal arteries. It furnishes offsets to the extensor brevis digitorum, and to the tarsal articulations.

**2.** The **metatarsal artery,** arising near the bases of the metatarsal bones, is also directed outwards beneath the short extensor muscle, and terminates in branches which anastomose with offsets of the tarsal and external plantar arteries. It supplies small branches to the extensor brevis digitorum muscle and the articulations of the foot, and from the fore part of the arch formed by the vessel three dorsal interosseous arteries are given off.

The *dorsal interosseous arteries* (vi) pass forwards over the outer three intermetatarsal spaces, resting upon the dorsal interosseous muscles, to which they furnish small offsets. Opposite the metatarso-phalangeal articulations, each artery divides into two *dorsal digital* branches, which run along the contiguous borders of the corresponding toes. These arteries communicate with the plantar arch at the back part of the interosseous spaces by means of the posterior perforating branches, and, less constantly, with the plantar digital arteries at the fore part of the spaces by the anterior perforating branches. From the outermost interosseous artery, or from the metatarsal artery itself, a small branch is given off to the outer border of the little toe.

**3.** The **first dorsal interosseous artery** (**v**), continuing the direction of the dorsal artery of the foot, runs forwards over the dorsal interosseous muscle of the first space, communicates with the corresponding plantar digital artery by an anterior perforating branch, and divides into *dorsal digital* branches for both sides of the great toe, and the inner side of the second toe. The branch to the inner side of the great toe is, however, frequently small or wanting.

**4.** The **plantar digital branch** passes forwards in the first interosseous space, sends inwards across the first metatarsal bone the artery for the inner side of the great toe, and terminates by dividing into collateral digital branches for the adjacent sides of the first and second toes.

**Varieties of the anterior tibial artery.**—*Origin.*—In instances of early division of the popliteal artery, the place of origin of the anterior tibial is necessarily higher than usual, and in these cases the commencement of the vessel may either descend by the side of the posterior tibial artery behind the popliteus, or it may pass in front of that muscle, resting against the outer tuberosity of the tibia, to reach the upper end of the interosseous space. The peroneal artery is occasionally found conjoined with the anterior tibial, that vessel having either a normal or a high origin.

*Course.*—The anterior tibial artery has been observed inclining outwards towards the fibula in the lower part of the leg, and then returning to its ordinary position on the dorsum of the foot. It has also been seen coming to the surface in the middle of the leg, and continued downwards from that point, covered only by the fascia and the integument, (Pelletan, "Clinique Chirurgicale," p. 101; Velpeau, "Médecine Opératoire," t. i. p. 137). Velpeau also states that in one case the artery gained the front of the leg by passing with the musculo-cutaneous nerve round the outer side of the fibula.

*Size.*—This vessel is more frequently diminished than increased in size.

It may be defective in various degrees. Thus, the dorsal artery of the foot may fail to enter the sole, and the digital branches to the great and second toes are then derived from the external or the internal plantar division of the posterior tibial. In a farther degree of diminution, the anterior tibial ends at the ankle, or in the lower part of the leg; its place being then taken by the anterior peroneal artery, which forms the dorsal artery of the foot, the two vessels (anterior tibial and anterior peroneal) being either connected together or separate.

A few cases are recorded in which the anterior tibial artery was altogether wanting, its place in the leg being supplied by perforating branches from the posterior tibial artery, and on the dorsum of the foot by the anterior peroneal artery.

This artery is occasionally larger than usual, in that case compensating for a defective condition of the external plantar artery.

The *dorsal artery of the foot* is not unfrequently found curving outwards below the ankle-joint, and returning to its usual position at the back of the first interosseous space. It has also been seen passing through the second space into the sole.

The *metatarsal artery* varies greatly in its arrangement. It is sometimes given off higher than usual, and it occasionally arises in common with the tarsal artery. It may be smaller than usual or absent, the deficiency being supplied by the tarsal artery, which furnishes one or more of the outer dorsal interosseous arteries (fig. 286). Occasionally there are two metatarsal arteries.

The *dorsal interosseous arteries* are sometimes derived mainly or solely from the plantar arch, by means of the posterior perforating branches.

## SURGICAL ANATOMY OF THE ARTERIES OF THE LEG.

The *posterior tibial artery* may be tied at any spot in the lower two-thirds of the leg. To reach the artery in the middle third, an incision from three to four inches in length is made through the skin and fascia, parallel to, and about half an inch behind, the internal border of the tibia. The inner head of the gastrocnemius being drawn backwards, and the internal saphenous vein (if exposed) forwards, the fleshy fibres of the soleus are cut through until the deep aponeurosis of the latter muscle is reached. This is then divided for the whole length of the wound, and the deep layer of fascia, which is here thin, is exposed. On laying this open the artery is at once seen, being placed between the companion veins, and having the nerve to its outer side.

In the lower third of the leg, the artery is readily tied by means of an incision two inches long, placed midway between the inner border of the tibia and the edge of the tendo Achillis, and carried through the integument and the two layers of fascia.

The *peroneal artery* might, if necessary, be secured in the middle third of the leg. An incision, from three to four inches long, is made through the skin and fascia immediately behind the outer border of the fibula, and the soleus drawn backwards. The fibres of the flexor longus hallucis are then to be divided close to the fibula, until the membranous wall of the canal containing the vessel is exposed, and on laying this open the artery will be found resting against the bone.

In order to apply a ligature to the *anterior tibial artery*, an incision is made along the front of the leg in the line of the vessel (see p. 483) for a distance of about three inches. In the upper part a longer incision is necessary than in the lower, in consequence of the greater depth of the artery, and a short transverse cut on each side through the dense fascia will facilitate the subsequent steps of the operation. The areolar interval between the tibialis anticus and the extensor longus digitorum is then opened up, and the muscles drawn well to the sides; in the lower part of the leg the extensor proprius hallucis must also be drawn outwards. The artery is then found lying upon the interosseous membrane, or upon the bone, according to the level at which it is exposed. The nerve is either superficial to, or on the outer side of the vessels. In the lower third of the leg, the outer border of the tendon of the tibialis anticus muscle is the best guide to the artery.

The *dorsal artery of the foot* is tied by means of an incision an inch and a half in length, placed midway between the tendons of the extensor proprius hallucis and extensor longus digitorum muscles. On dividing the fascia, the artery is found passing beneath the innermost slip of the extensor brevis digitorum, and having the companion nerve generally to its outer side. The aponeurotic layer binding the vessels against the bone must also be cut through to bring them fully into view.

## SYSTEMIC VEINS.

The systemic veins commence by small branches which receive the blood from the capillaries throughout the body, and unite to form larger vessels, which end at last by pouring their contents into the right auricle of the heart through two large venous trunks, the superior and inferior venæ cavæ. The blood from the walls of the heart itself is returned by the cardiac veins also to the right auricle.

The veins, however, which bring back the blood from the stomach, intestines, spleen, and pancreas, have an exceptional destination, not conveying the blood directly to the heart, but joining to form a single trunk—the portal vein, which again becomes ramified in the substance of the liver, and carries its blood to the capillaries of that organ. Thence the blood passes into the ultimate twigs of the hepatic veins, and is conveyed by these veins into the inferior vena cava. The veins thus passing to the liver constitute the *portal system.*

The anastomoses of veins are much larger and more numerous than those of arteries. The veins of the body generally consist of a subcutaneous and a deep set, which have very frequent communications with each other. In some parts of the body, chiefly in the limbs and at the surface, the veins are provided with valves, while in others no valves exist (see Vol. II. p. 192).

The systemic veins are naturally divisible into two groups: firstly, those from which the blood is carried to the heart by the superior vena cava, viz., the veins of the head and neck and upper limbs, together with those of the spine and a part of the walls of the thorax and abdomen, with which may be associated also the veins of the heart; and secondly, those from which the blood is carried to the heart by the inferior vena cava, viz., the veins of the lower limbs, the lower part of the trunk, and the abdominal viscera. (For a general representation of the venous system, see fig. 225, p. 348.)

### VEINS OF THE HEART.

The greater number of the cardiac veins are collected into a large common trunk which pours its blood into the posterior part of the right auricle, in the angle between the orifice of the inferior vena cava and the right auriculo-ventricular orifice. The terminal part of this trunk is somewhat dilated, and is named the coronary sinus. The veins leading into the sinus are named the left or great, the posterior, the middle, and the right or small cardiac veins. In addition to these, there are also the anterior and the smallest cardiac veins, which open separately into the right auricle. The veins of the heart are without valves, excepting at their terminations.

The **great cardiac** or **coronary vein** commences near the apex of the heart, and ascends, increasing gradually in size, along the anterior interventricular groove, in company with the anterior branch of the left coronary artery. It then turns backwards, by the side of the posterior branch of the same artery, in the groove between the left auricle and ventricle, and, having gained the posterior surface of the heart, terminates in the left end of the coronary sinus. In the first part of its course it receives branches from the interventricular septum and from the anterior wall of both ventricles; and as it passes backwards it is joined by descending branches from the left auricle, and by ascending branches from the ventricle, one of which, lying along the left margin of the heart, is of considerable size. A valve, generally of two segments, is placed over the opening of the vein in the coronary sinus.

Fig. 287.

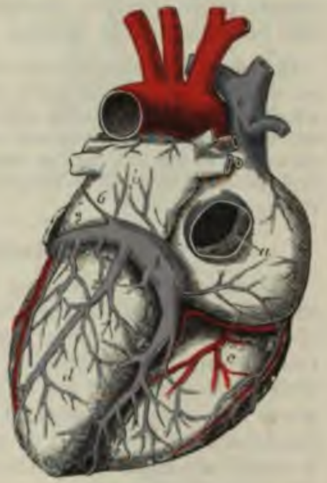


Fig. 287.—THE HEART, FROM BEHIND, TO SHOW THE CARDIAC VEINS. (A. T.) $\frac{1}{2}$

*a*, placed on the right auricle, points to the Eustachian valve seen within the opening of the inferior vena cava; *b*, left auricle; *c*, right ventricle; *d*, left ventricle; *e*, superior vena cava; *f*, arch of the aorta; 1, coronary sinus; 2, great coronary vein, turning round the heart in the auriculo-ventricular groove; 3, posterior cardiac veins; 4, middle cardiac vein; the small coronary vein is seen joining the right end of the coronary sinus; 5, one of the anterior cardiac veins passing directly into the right auricle; 6, the oblique vein, proceeding downwards over the left auricle to join the coronary sinus.

The **posterior cardiac veins** are three or four in number, and ascend on the posterior surface of the left ventricle to open into the coronary sinus along its lower border. Sometimes one of these veins is much larger than the others.

The **middle cardiac vein,** of considerable size, commences at the apex of the heart, where it communicates with the radicles of the great coronary vein, and passes upwards in the posterior interventricular groove to join the right extremity of the coronary sinus. It receives branches from the interventricular septum, and from the posterior wall of both ventricles, but more particularly the right.

The **right** or **small coronary vein** collects blood from the hinder parts of the right auricular and ventricular walls, and passes transversely in the groove between the right auricle and ventricle to open into the right end of the coronary sinus. This small vein is often represented by two or three separate branches, and it is occasionally absent.

The **coronary sinus** is about an inch in length, and is placed at the back of the heart, in the groove between the left auricle and ventricle, where it is covered by the muscular fibres of the auricle. At its termination it opens into the right auricle, immediately in front of the inferior vena cava, and its orifice is covered by the Thebesian valve. The sinus is joined by the principal veins of the heart in the manner described above, and also at its left extremity by a small straight vein (*oblique vein* of Marshall) which runs downwards and inwards over the back of the left auricle. All the veins joining the sinus, except the small oblique vein which is often imperforate, are provided with more or less complete valves at their terminations.

The **anterior cardiac veins** are two or three small vessels running upwards on the front of the right ventricle, and one of larger size ascending along the right border of the heart, all of which open into the auricle immediately above the auriculo-ventricular groove. These veins have no valves.

The **smallest cardiac veins** (venæ cordis minimæ), very variable in number, are contained in the substance of the heart, and open into the right auricle, especially upon and in the neighbourhood of the inter-auricular septum, giving rise to some of the foramina Thebesii. Similar minute veins open into the left auricle, and according to L. Langer also into both ventricular cavities.

The coronary sinus, together with the small oblique vein, considered with reference to their early fœtal condition and certain abnormal conditions to which they are subject along with other neighbouring veins, may be looked upon rather as the persistent terminal parts of a typically distinct left superior vena cava (duct of Cuvier), than as simply the main stem of the cardiac veins. The explanation of this will be found in the description of the development of these veins.

## SUPERIOR VENA CAVA.

The superior or descending vena cava conveys to the heart the blood which is returned from the head and neck, the upper limbs, and the walls of the thorax. It is formed by the union of the right and left innominate veins, behind the junction of the first costal cartilage of the right side with the sternum, and descends nearly vertically to the base of the heart, where it opens into the right auricle, opposite the upper border of the third costal cartilage. It is about three inches long, and in its course it describes a slight curve, the convexity of which is directed to the right side. It has no valves.

At its commencement, the superior vena cava is placed on the right side of the innominate artery, and is covered in front and externally by the pleura. The right phrenic nerve also lies along its outer side. About an inch and a half above its termination, it perforates the fibrous layer of the pericardium, the serous membrane being reflected over it and surrounding it except along its posterior surface. The lower part of the vein lies in front of the right division of the pulmonary artery and the upper right pulmonary vein, and the ascending part of the arch of the aorta is to its inner side.

The superior vena cava receives small pericardial and mediastinal veins, and immediately above the place where it perforates the pericardium it is joined by the large azygos vein.

### INNOMINATE VEINS.

The innominate or brachio-cephalic veins, commencing on each side by the union of the subclavian and internal jugular veins behind the inner end of the clavicle, transmit the blood returning from the head and neck, the upper limbs, and a part of the thoracic wall. They end below by uniting to form the superior vena cava, beneath the junction of the first costal cartilage of the right side with the sternum. The right vein is about an inch in length, and descends nearly vertically by the side of the commencement of the subclavian and the upper end of the innominate artery; externally it is covered by the right pleura and lung, the phrenic nerve being interposed. The vein of the left side, nearly three times as long as the right, takes a course from left to right, at the same time inclining somewhat downwards: it crosses behind the upper part of the manubrium, being separated from the bone by the lower ends of the sterno-hyoid and sterno-thyroid muscles, and by the thymus gland or its remains; below it is the transverse part of the arch of the aorta, and behind it are the three large branches of the arch, as well as the left phrenic and pneumo-gastric nerves. The innominate veins have no valves.

Fig. 288.

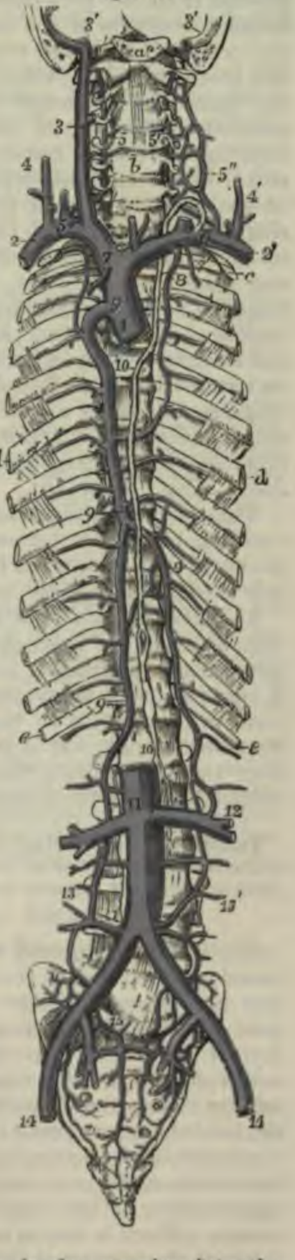


Fig. 288.—SKETCH OF THE PRINCIPAL VENOUS TRUNKS, TOGETHER WITH THE THORACIC DUCT. (A.T.) ⅕

*a*, basilar process of the occipital bone, through which and the temporal bones a transverse section has been made so as to lay open the jugular foramen on both sides; *b*, fifth cervical vertebra; *c*, first rib; *d*, the sixth; *e*, the twelfth; *f*, fifth lumbar vertebra; 1, superior vena cava divided at the place of its entrance into the right auricle; 2, right, 2′, left subclavian vein; 3, right internal jugular vein; 3′, 3′, lower parts of the lateral sinuses of the dura mater; that of the right side shows at its junction with the jugular vein the bulb which lies in the jugular fossa of the temporal bone; 4, right, and 4′, left external jugular vein; 5, right, and 5′, left vertebral vein, being joined by 5″, the anterior vertebral vein, before entering (in this case) the subclavian vein; 6, placed on the left subclavian vein below the opening of the last, and of the thoracic duct; below *b*, the inferior thyroid veins; 7, 7′, internal mammary veins; 8, the left superior intercostal vein, joining the left innominate, and anastomosing below with the left upper azygos vein; the right superior intercostal vein is seen joining the large azygos vein; 9, 9, 9, large azygos vein; 9′, left lower azygos vein; 10, thoracic duct; 11, inferior vena cava, at the place of junction of the renal veins; 12, communication of the left lower azygos vein with the left renal vein; 13, 13′, right and left ascending lumbar veins, continued upwards into the corresponding azygos veins; 14, 14′, external iliac veins, which are joined higher up by the internal iliacs, to form the common iliac veins; 15, placed on the promontory of the sacrum, points on either side to the prolongation of the lower branches of the lumbar veins into the pelvis, and their union with sacral and other branches of the internal iliac veins.

LATERAL TRIBUTARIES.—Both innominate veins are joined by the vertebral, inferior thyroid and internal mammary veins; that of the left side also by the superior intercostal, and some small thymic, mediastinal and pericardial veins. There is also, opening into the angle of union of the internal jugular and subclavian veins, on the left side the thoracic duct, on the right side the right lymphatic duct.

The **vertebral vein** is formed by the union of branches which proceed from the pericranium and the deep muscles lying behind the foramen magnum of the occipital bone, and which anastomose with the the occipital, with the commencement of the deep cervical, and with the posterior spinal veins. It passes downwards with the artery of the same name through the canal formed by the foramina in the transverse processes of the upper six cervical vertebræ, and then, inclining forwards, descends across the subclavian artery, and under cover of the internal jugular vein, to open into the commencement of the innominate vein posteriorly, where its orifice is guarded by a single or double valve (Struthers). The vertebral vein receives in its course downwards several branches from the neighbouring muscles, and branches from the spinal canal issuing by the intervertebral foramina; it communicates freely with the dorsal spinal veins of the neck, and with a venous plexus which surrounds the transverse processes and extends over the anterior surface of the cervical vertebræ; and near its termination it is joined by the anterior vertebral and deep cervical veins, as well as by a small vein from the first intercostal space, which accompanies the superior intercostal artery. The last branch may, however, open independently into the innominate vein (B. G. Morison, Journ. Anat., xiii., 346).

The *anterior vertebral vein* issues from the plexus over the cervical vertebræ, and passes downwards in company with the ascending cervical artery, receiving branches from the prevertebral and scaleni muscles, to join the lower end of the vertebral vein.

The *deep cervical vein* (posterior vertebral), a vessel of large size, commences in the suboccipital region, and descends between the complexus and semispinalis muscles to the lower part of the neck, where it turns forwards below the transverse process of the seventh cervical vertebra, to unite with the vertebral vein just before that enters the innominate trunk. It is joined by the occipital veins and by branches from the deep parts at the back of the neck, and it has numerous communications with the dorsal spinal veins.

**Varieties.**—The vertebral vein not unfrequently passes through the foramen in the transverse process of the seventh cervical vertebra, or sends a considerable offset through that foramen to join the deep cervical vein.

The **inferior thyroid veins** are of large size, and are formed by branches which emerge from the lateral lobe of the thyroid body, where they anastomose with the superior and middle thyroid veins. They form a plexus on the front of the trachea below the isthmus of the thyroid body, and then descend along that tube, under cover of the sterno-thyroid muscles, receiving on their way downwards œsophageal, inferior laryngeal and tracheal branches. The vein of the left side joins the left innominate trunk; that of the right side either terminates in common with the foregoing, or it inclines somewhat outwards across the innominate artery, and opens into the angle of union of the two innominate veins, or less frequently into the lower end of the right innominate. There is also in some cases an additional median vein descending from the isthmus of the thyroid body.

municates with the anterior jugular vein, and passes backwards under cover of the base of the lower jaw, receiving branches from the muscles and the submaxillary gland, to join the facial vein.

Fig. 289.

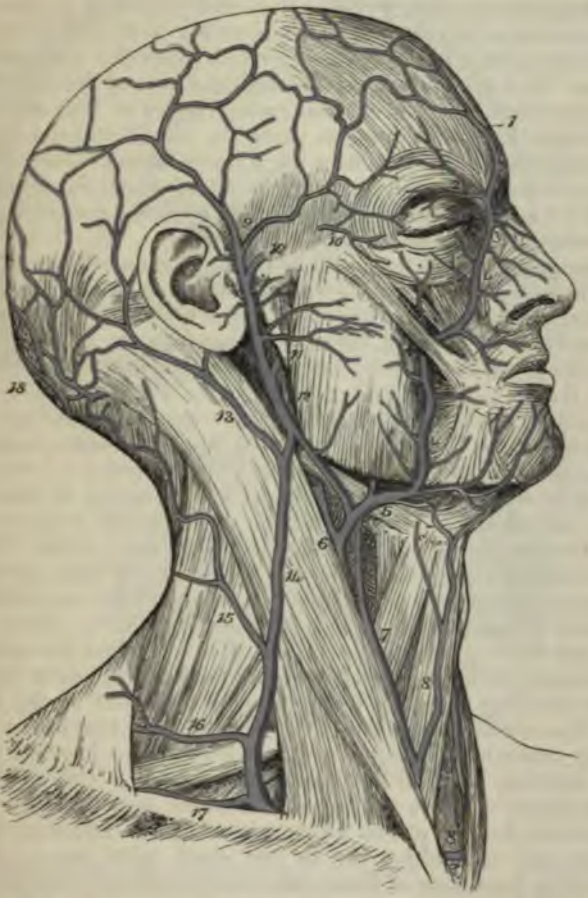


Fig 289.—SUPERFICIAL VEINS OF THE HEAD AND NECK. (G.D.T.) ⅓

1, frontal vein; 2, supraorbital; 3, angular vein, receiving superior palpebral and nasal branches; 4, 4, facial vein on the face, receiving inferior palpebral, superior labial, parotid and masseteric branches; + indicates the spot where it is joined by the deep facial vein; 5, facial vein in the neck, being joined by submental, with inferior labial, glandular and inferior palatine branches; 6, common facial vein, joining the internal jugular; 7, communicating branch to 8, the anterior jugular; 8′, transverse branch connecting the two anterior jugular veins; 9, superficial temporal, and 10, middle temporal, uniting to form the common temporal vein, which is receiving anterior auricular and transverse facial branches; 10′, orbital branch of middle temporal; 11, internal maxillary vein; 12, temporo-maxillary vein, the anterior division of which unites with the facial, while the posterior joins 13, the posterior auricular vein, to form 14, the external jugular; 15, posterior external jugular; 16, transverse cervical; 17, suprascapular vein; 18, occipital veins.

(*i*) *Submaxillary* branches from the gland of that name join the facial vein either separately or in common with the submental vein.

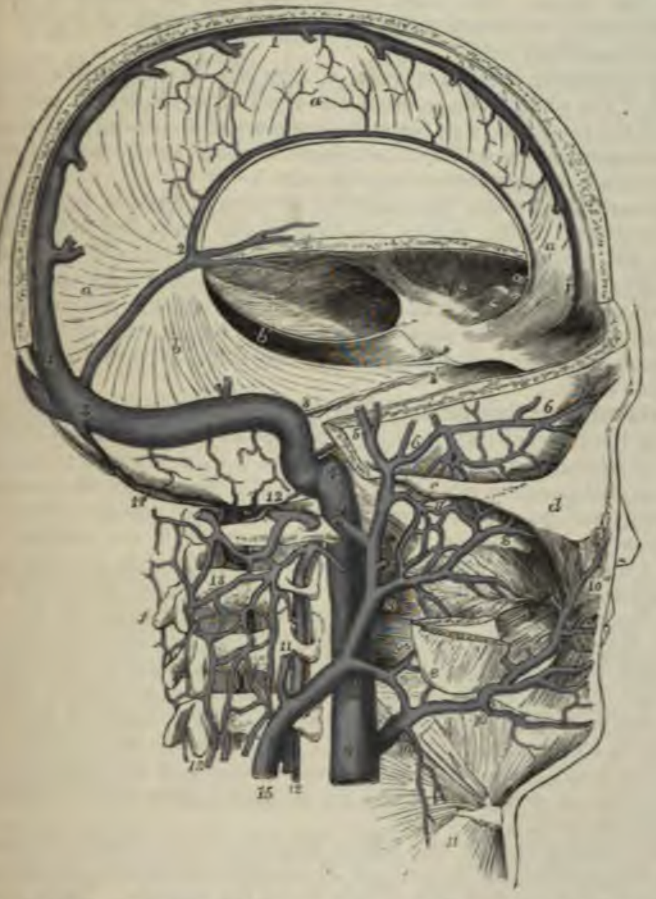
(*j*) The *inferior palatine vein* returns the blood from a plexus surrounding the tonsil and from the soft palate; it passes downwards, being deeply seated by the side of the pharynx, to join one of the preceding, or terminate separately in the facial vein.

The **temporo-maxillary vein** (posterior facial) is a short trunk, often presenting a plexiform disposition, which is formed by the union of the temporal and internal maxillary veins opposite the neck of the lower jaw. It descends, embedded in the substance of the parotid gland, on the outer surface of the external carotid artery to near the angle of the jaw, where it divides into two parts, the one of which inclines forwards, passing either over or under the stylo-hyoid and digastric muscles, to join the facial vein, while the other is directed backwards across the border of the sterno-mastoid muscle to form with the posterior auricular the commencement of the external jugular vein.

The **temporal vein** is formed close to the zygoma by the union of two vessels which are known as the superficial and middle temporal veins. The *superficial temporal vein* takes its origin in branches which spread over the top and side of the head, communicating with one another, with the corresponding vessels of the opposite side, with the frontal vein anteriorly, and with the occipital and posterior auricular veins behind, so as to form a wide-meshed plexus in the subcutaneous tissue. Descending over the temporal fascia, the branches are collected into two vessels corresponding to, although not closely accompanying, the divisions of the artery, superficial to which they are placed, and these joining in front of the ear give rise to the superficial trunk. The *middle temporal vein* is derived from a plexus in the temporal fossa, from which the deep temporal veins (passing to the pterygoid plexus) also issue, and piercing the temporal fascia near the zygoma unites with the superficial vein. The middle temporal vein is joined by a considerable *orbital* branch, which, after receiving some *external palpebral veins* from the eyelids, and communicating with the supraorbital and facial veins, passes backwards with the artery of the same name between the layers of the temporal fascia. The *common temporal vein* descends over the base of the zygoma, and sinks beneath the parotid gland to form by its junction with the internal maxillary vein the temporo-maxillary trunk. Other tributaries of the temporal vein are the *anterior auricular veins* from the external ear; branches from a plexus which surrounds the articulation of the lower jaw, and into which one or two small veins issuing from the tympanum by the fissure of Glaser pour their contents; *parotid* branches from the gland; and one or two *transverse facial veins* from the surface of the masseter muscle.

The **internal maxillary vein** is a short vessel, often double, which passes backwards from the pterygoid plexus in the zygomatic fossa, in company with the first part of the internal maxillary artery, and joins the temporal vein behind the ramus of the jaw. The *pterygoid plexus*, corresponding to the second and third parts of the internal maxillary artery, is a close network of veins covering both surfaces of the external pterygoid muscle, and extending also over the inner surface of the internal pterygoid. It receives tributaries which are mostly companion veins of the branches of the internal maxillary artery. Thus, three or four *deep temporal veins* descend from the temporal muscle, and other ches come from the pterygoid and masseter muscles ; a *posterior* *al* or *alveolar* branch ascends from the surface of the upper jaw, and

Fig. 290.



290.—DIAGRAMMATIC VIEW OF THE SINUSES OF THE DURA MATER AND SOME OF THE EP VEINS OF THE HEAD AND NECK (modified from Cloquet and other sources). (A.T.) ½

he greater part of the calvaria has been removed, but an arched strip has been left e region of the superior longitudinal sinus. The occipital portion of the skull has entirely removed so as to expose the lateral sinus and its termination in the internal lar vein ; *a*, *a*, falx cerebri ; *b*, *b'*, tentorium cerebelli ; *c*, zygoma ; *d*, malar bone ; gle of jaw ; *f*, spinous process of axis ; 1, superior longitudinal sinus ; 2, inferior itudinal sinus ; 2, to 3, straight sinus ; 2', veins of Galen ; 3, lateral sinus, descend- to 4, the commencement of the internal jugular vein ; 3', superior petrosal sinus ; internal jugular vein ; 5, superficial temporal vein ; 6, middle temporal ; 8, internal illary joining the common temporal vein to form the temporo-maxillary trunk ; 8', ygoid plexus receiving the deep temporal veins ; 9, anterior division of the temporo- illary trunk, joining the facial vein ; 9', inferior palatine vein ; 10, common facial ; 10', submental vein ; 10'', upper part of the facial ; 11, posterior auricular vein ; 12, vertebral vein ; 13, 13, dorsal spinal veins ; 14, occipital sinus communicating e the atlas with the posterior spinal plexus ; 15, external jugular vein.

another of larger size, *inferior dental*, from the canal in the lower jaw; two *middle meningeal veins* accompany the artery of the same name; and lastly, *superior palatine, infraorbital*, and *spheno-palatine veins*, as well as a communicating branch from the inferior ophthalmic vein, also enter the plexus. The blood is conveyed from the plexus by the deep facial vein (p. 494) anteriorly, and posteriorly by the single or double internal maxillary vein.

The **posterior auricular vein,** of large size in comparison with the artery of the same name, collects the blood from the hinder part of the side of the head and from the cranial surface of the auricle; it descends over the mastoid process and the upper end of the sterno-mastoid muscle, to terminate in the external jugular vein.

The **occipital veins**, generally two or three in number, issue from the hindmost part of the venous network of the scalp, the most external being also connected in most cases with the lateral sinus within the skull by means of the emissary vein occupying the mastoid foramen (this vein sometimes joins a branch of the posterior auricular); descending over the occipital bone, they pass deeply between the muscles of the back of the neck, and empty themselves into the commencement of the deep cervical vein.

**External jugular vein.**—This vein commences near the angle of the jaw by the union of the posterior auricular and the posterior division of the temporo-maxillary veins. It descends with a nearly vertical course between the platysma myoides and the fascia, crossing the sterno-mastoid obliquely and gaining the posterior border of that muscle below. Near the clavicle it perforates the fascia, the margin of the opening being closely united to the wall of the vessel, and then inclines slightly inwards to terminate most frequently in the subclavian vein at the outer border or in front of the anterior scalenus muscle, sometimes in the lower end of the internal jugular, or in the angle between the two large veins. It is joined below the middle of the neck by a considerable vein (*posterior external jugular*) which descends from the occipital region, collecting branches from the integument and the superficial muscles of the back of the neck, and near its termination by the *transverse cervical* and *suprascapular veins* from the shoulder, corresponding to the arteries of the same name, as well as usually by the anterior jugular vein from the fore part of the neck.

The external jugular vein has an imperfect valve close to its termination, and another, which, however, is generally sufficient to prevent regurgitation, about an inch and a half above the clavicle. There are also valves in the transverse cervical and suprascapular veins, either at or a short distance from their orifices (Struthers, "Anat. and Phys. Observ.," p. 246).

The **anterior jugular vein** takes its origin in the submaxillary region by the union of branches, some of which proceed from the superficial structures of this part and form communications with the submental vein, while others descend from the lower lip and chin. The vessel runs down the front of the neck, being placed a variable distance from the middle line, and frequently being connected by one or more cross branches with the external jugular vein; near the inner end of the clavicle it perforates the fascia, and, after being joined in most cases by a communicating branch from the facial vein, is then directed outwards behind the origin of the sterno-mastoid muscle to open into the lower end of the external jugular vein, or sometimes directly into the subclavian vein. The lower parts of the two anterior jugular veins are generally united by a transverse branch contained in the interfascial space at the upper border of the sternum (p. 289).

**Varieties of the superficial veins of the head and neck.**—These veins are subject to many deviations from the arrangement above described. Thus, the relative size of the two divisions of the *temporo-maxillary vein* varies greatly, and it not unfrequently happens that one is very small or even absent, so that the trunk is continued mainly or wholly in one set of cases into the external jugular vein, in another set into the internal jugular through the common facial vein. The *facial vein* occasionally passes backwards over the sterno-mastoid muscle and joins the external jugular vein ; or it may be continued downwards, by means of an enlargement of the normal communicating branch, into the anterior jugular vein. In those instances in which the temporo-maxillary vein passes entirely into the internal jugular, the *external jugular vein* is very small, being formed solely by the posterior auricular vein ; and in such cases the posterior auricular vein may also join the temporo-maxillary trunk, so that the external jugular vein is then altogether wanting in the greater part of the neck. The lower part of the external jugular vein is occasionally connected with the cephalic vein of the arm by means of a branch passing downwards over the clavicle, and in rare cases the whole vein has been seen taking this course and dipping into the infraclavicular fossa to join the cephalic, or to open into the subclavian vein above the subclavius muscle. The *transverse cervical* and *suprascapular veins* not unfrequently open independently into the subclavian vein. The *anterior jugular vein* varies greatly in size, and the right and left veins are sometimes united into a single median vessel for a part of their length. As a rare occurrence the anterior jugular vein passes outwards in front of the sternomastoid muscle.

**Internal jugular vein.**—This vein, receiving the blood from the cranial cavity, is continuous at its upper extremity with the lateral sinus within the skull, and terminates inferiorly in the innominate vein. It commences in the large posterior compartment of the jugular foramen by a dilatation which is termed the *sinus* or *bulb* of the internal jugular vein, and then makes its appearance below the base of the skull, where it rests against the rectus capitis lateralis muscle, being placed close behind the internal carotid artery. Inclining gradually to the outer side of that vessel, it descends with a nearly straight course in the neck, and becoming considerably increased in size about the level of the hyoid bone by the junction of the common facial, as well as of several deep veins, it thence accompanies the common carotid artery to the back of the clavicle, under cover of which it unites at a right angle with the subclavian vein. The internal jugular vein lies on the outer side of, and frequently overlaps somewhat, the common carotid artery, and the two vessels, together with the pneumo-gastric nerve, are contained in the same sheath of the deep cervical fascia. Close to, or within an inch of, the lower end of the vein is placed a single or double valve, which is however generally insufficient to completely prevent regurgitation, especially on the left side, where it is not unfrequently absent (Gruber).

*Lateral tributaries.*—(*a*) The *inferior petrosal sinus* leaves the skull by the anterior compartment of the jugular foramen, and opens immediately into the internal jugular vein.

(*b*) *Pharyngeal veins.*—These veins form a plexus which covers the outer surface of the pharynx, communicating above on the inner side of the internal pterygoid muscle with the pterygoid plexus, and collecting branches also from the soft palate, the Eustachian tube, and the prevertebral muscles. From this plexus two or three vessels descend, and open into the internal jugular or the common facial vein, either separately or in union with the lingual or superior thyroid veins.

(*c*) *Lingual veins.*—The blood conveyed to the tongue by the lingual artery is returned by means of—1, the *ranine vein*, the largest of the lingual veins, which commences below the tip of the tongue, and passes backwards at first beneath the mucous membrane, and afterwards across the outer surface of the hyo-glossus muscle, in company with the hypoglossal nerve, receiving branches from the substance of the tongue, the surrounding muscles, the sublingual gland, and the mucous membrane of the floor of the mouth; 2, two *venæ comites* of small size which accompany the lingual artery; and 3, the *dorsal veins of the tongue*, which proceed from a plexus beneath the mucous membrane on the posterior third of that organ. These vessels are sometimes united in a short common trunk, but more frequently they open separately into the internal jugular or common facial vein.

(*d*) The *common facial vein* has already been described.

(*e*) The *superior thyroid vein* leaves the upper part of the thyroid body, after communicating freely with the other thyroid veins, and ascends to join the internal jugular or frequently the common facial vein. It receives branches from the surrounding muscles, and the *superior laryngeal* and *crico-thyroid veins.*

(*f*) The *middle thyroid vein* issues from the lateral lobe of the thyroid body, and crosses the common carotid artery to join the internal jugular vein on a level with, or a little below, the cricoid cartilage.

## VENOUS CIRCULATION WITHIN THE CRANIUM.

The part of the venous system contained within the skull consists of veins properly so called, and of certain channels named *sinuses*, which receive the blood from those veins, and conduct it to the internal jugular veins. The sinuses alluded to are spaces left between the layers of the dura mater, the fibrous covering of the brain.

### VEINS OF THE BRAIN.

The **veins of the cerebrum** are divided into superficial, which ramify upon its surface, and deep which are placed within its ventricles. The former are again subdivided into superior and inferior.

The *superior cerebral veins*, ten to twelve in number on each side, run inwards over the upper surface of the large brain, lying for the most part in the sulci between the convolutions, to the margin of the longitudinal fissure, where they are joined by branches which ascend on the mesial surface of the hemisphere, and then open into the superior longitudinal sinus. The anterior veins are small, and are directed transversely inwards; the middle and posterior are larger, pass obliquely forwards, and finally are embedded for a short distance in the wall of the sinus before opening into its cavity. Unlike the arteries, these vessels anastomose freely with one another and with the inferior cerebral veins.

The *inferior cerebral veins* pass from the outer and lower surfaces of the hemisphere to the cavernous, superior petrosal and lateral sinuses. One of these vessels, known as the *middle cerebral vein*, is of large size, and, after collecting branches from the under surface of the frontal and temporo-sphenoidal lobes, emerges from the lower part of the fissure of

Sylvius to enter the cavernous sinus. Another is the *great anastomotic vein* of Trolard, which commences on the surface of the parietal lobe, where it anastomoses with the upper cerebral veins, and runs forwards in the posterior limb of the fissure of Sylvius; it perforates the dura mater near the apex of the small wing of the sphenoid, and then passes backwards in the middle fossa of the base of the skull, forming a communication with the middle meningeal veins, to join the superior petrosal sinus.

The *deep cerebral veins* are collected into two trunks, which are known as the *veins of Galen*. These vessels commence close to the foramen of Monro, being formed on each side by the union of the *choroid vein*, which ascends from the inferior cornu of the lateral ventricle along the margin of the velum interpositum, returning the blood from the choroid plexus of that cavity, and the *vein of the corpus striatum*

Fig. 291.

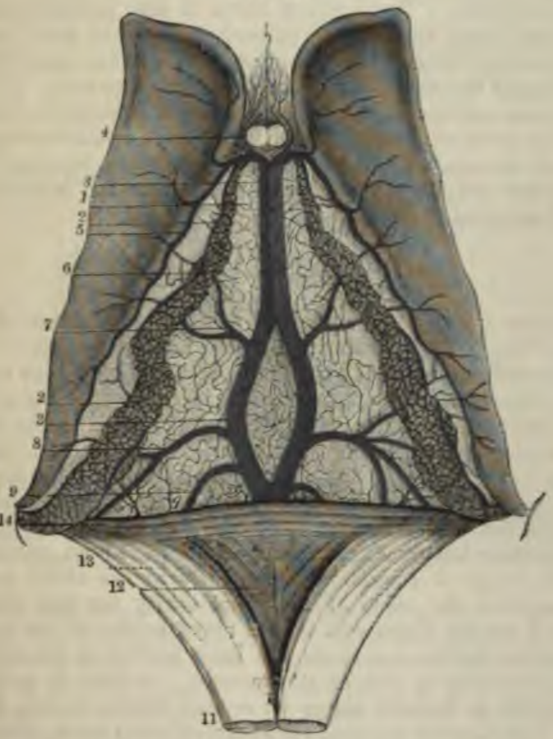


Fig. 291.—UPPER SURFACE OF THE VELUM INTERPOSITUM, WITH THE CHOROID PLEXUSES OF THE LATERAL VENTRICLES AND THE VEINS OF GALEN (from Sappey after Vicq-d'Azyr). $\frac{3}{2}$

1, fore part of the velum interpositum; 2, choroid plexus; 3, 3, left vein of Galen; 4, veins from the corpus callosum and septum lucidum; 5, vein of the corpus striatum; 6, choroid vein; 7, vein from the optic thalamus; 8, basilar vein; 9, vein from the posterior cornu of the lateral ventricle; 11, 12, 13, fornix, divided anteriorly and turned backwards; 14, splenium of the corpus callosum.

which passes forwards in the groove between the corpus striatum and optic thalamus, being joined in its course by branches from both these bodies, and near its termination by veins from the septum lucidum and the anterior cornu of the ventricle. The right and left veins of Galen run backwards, lying close together between the layers of the velum interpositum, and beneath the splenium of the corpus callosum they join into a short common trunk (*vena magna Galeni*) which opens into the anterior extremity of the straight sinus. They receive on their way branches from the inner side of the optic thalamus and the choroid plexuses of the third ventricle, the *basilar vein* which ascends from the base of the brain round the outer side of the crus cerebri, and small vessels from the corpora quadrigemina and pineal body, and from the posterior cornu of the lateral ventricle. The common trunk is also joined by veins from the inner and lower surfaces of the occipital lobe of each hemisphere, and by some small veins from the upper surface of the cerebellum.

The **veins of the cerebellum** are disposed in two sets. The *superior cerebellar veins* are directed partly upwards and inwards to the straight sinus and the vena magna Galeni, partly outwards to the superior petrosal and lateral sinuses. The *inferior cerebellar* veins, together with the veins from the medulla oblongata and pons, enter the inferior petrosal, lateral and occipital sinuses.

## VENOUS SINUSES OF THE CRANIUM.

The sinuses are channels contained within the substance of the dura mater, and lined by a delicate membrane which is continuous with the internal coat of the veins. They admit of a division into two groups, viz., a supero-posterior group, lodged almost entirely in the processes of the dura mater, and an infero-anterior group, situated in the base of the skull. To the former belong the superior longitudinal, the inferior longitudinal, the straight, the lateral, and the occipital sinuses: the latter includes the cavernous, the circular, the superior and inferior petrosal, and the basilar sinuses.

The **superior longitudinal sinus** (fig. 290, 1) commences at the crista galli, where it sometimes (constantly in the child) has a communication with the veins of the nasal cavity through the foramen cæcum, and extends backwards in the upper border of the falx cerebri, occupying the median groove on the inner surface of the calvaria, and increasing gradually in size as it proceeds. In form it is three-sided, and its cavity is bridged across by several fibrous bands, the *chordæ Willisii*. The superior cerebral veins open into this sinus, their apertures looking for the most part forwards, in a direction contrary to that of the current within it. It also communicates in many cases with the veins of the scalp, by means of an emissary vein which passes through the parietal foramen. As it descends on the occipital bone the superior longitudinal sinus usually deviates a little from the middle line, and inclines to one side (more frequently the right) of the internal occipital protuberance, where it becomes somewhat enlarged and bends sharply round at a right angle to be continued into the corresponding lateral sinus. This dilatation is lodged in a well-marked depression on the occipital bone, and constitutes what is termed the *torcular Herophili* or the *confluence of the sinuses*. From it a cross branch of variable size proceeds over the front of the occipital protuberance to a similar bend vessels (*anterior* and *posterior intercavernous sinuses*) which connect together the right and left cavernous sinuses. Either of these transverse branches may however be wanting, but the anterior, which is usually the larger, is the more constant. On the other hand, there is sometimes an additional vessel passing across below the pituitary body.

The **superior petrosal sinus** is a narrow canal running in the groove along the upper margin of the petrous part of the temporal bone. Commencing at the back part of the cavernous sinus, it is directed outwards and backwards in the attached margin of the tentorium cerebelli, and ends in the lateral sinus as this turns downwards in the groove on the mastoid part of the temporal bone. It is joined by some inferior cerebral and superior cerebellar veins, as well as by small branches from the tympanum, which issue by the petro-squamous fissure (p. 41).

The **inferior petrosal sinus**, much shorter and wider than the superior, passes from the cavernous sinus downwards and outwards in the groove along the lower margin of the petrous bone, between this and the basilar process of the occipital bone. It passes through the anterior compartment of the jugular foramen and opens immediately into the upper end of the internal jugular vein. The inferior petrosal sinus receives some inferior cerebellar veins, and the *auditory veins* from the internal ear.

The **transverse** or **basilar sinus** (basilar plexus—Virchow) is a venous network excavated in the dura mater over the basilar process of the occipital bone, opening into the inferior petrosal sinus on each side, and into the anterior spinal veins below.

**Varieties of the sinuses.**—The disposition of the sinuses around the *torcular Herophili* is subject to considerable variation. It occasionally happens that the lower part of the superior longitudinal sinus is placed in the middle line, and then the straight sinus opens into the front, while the lateral sinuses spring from the sides, of the torcular, so that a true confluence of the sinuses is formed. In other instances the connecting branch between the torcular and the straight sinus is of large size, and conveys blood from the superior longitudinal sinus, which then empties itself equally into both lateral sinuses. In either of the foregoing arrangements, the right and left lateral sinuses are of equal size, a condition, however, which is of comparatively unfrequent occurrence (Rüdinger, "Beiträge zur Anatomie" &c., München, 1876). A great diminution, or even absence, of one lateral sinus has been met with, the vessel of the opposite side being much enlarged.

The *occipital sinus* is sometimes wanting; or it may be of large size and form a groove on the occipital bone, by the side of the foramen magnum, as it passes forwards to the jugular foramen (fig. 292).

An additional *petro-squamous sinus* is sometimes present, lying in a small groove along the junction of the petrous and squamous portions of the temporal bone, and opening behind into the lateral sinus. In rare cases the petro-squamous sinus is found passing through an aperture (*foramen jugulare spurium*) in the squamous part of the temporal bone, between the orifice of the external auditory meatus and the glenoid cavity, and then joining the temporal vein, thus resembling the arrangement in the dog and many other animals, in which a similar vessel forms the principal outlet for the intracranial blood. In the human subject also, at an early period of fœtal life, the lateral sinus is continued forwards in this course, and opens into the primitive (afterwards the external) jugular vein, and the occurrence of a petro-squamous sinus is due to the persistence of this channel, which usually becomes obliterated after the development of the internal jugular vein. (On the varieties of the sinuses, see J. F. Knott, Journ. Anat., xvi., 27.)

### OPHTHALMIC VEINS.

The ophthalmic veins are two in number, and collect the blood from the parts within the orbit. The **superior**, much the larger, commences near the root of the nose by a wide communication with the angular vein, and is also joined, usually near its origin, by another communicating branch from the supraorbital vein. It passes backwards in company with the ophthalmic artery, crossing the optic nerve from within outwards, and gains the inner end of the sphenoidal fissure, where it opens into the fore part of the cavernous sinus. It is joined in its course by *anterior* and *posterior ethmoidal*, *muscular* and *lachrymal* branches, and near its termination by the *central vein of the retina*, all of

Fig. 293.

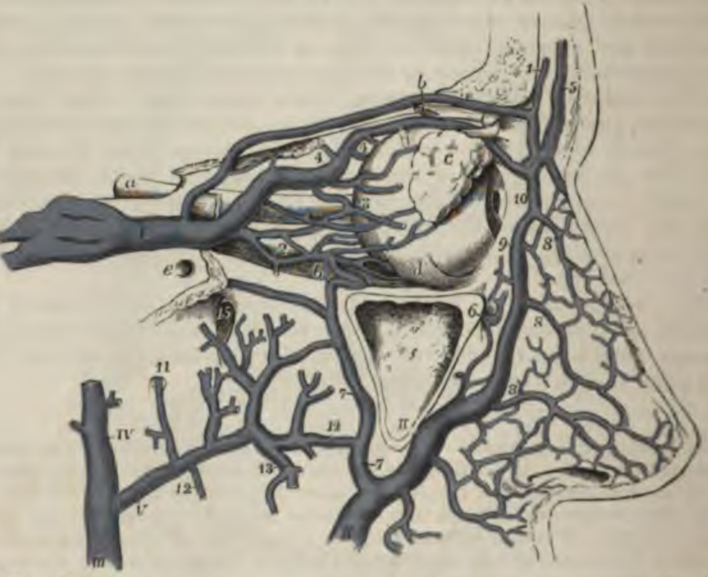


Fig. 293.—Sketch of the ophthalmic veins, showing their distribution and communications with other veins (altered from Hirschfeld and Leveillé). (A. T.)

The orbit is opened from the outer side and the dissection is similar to that for displaying the ophthalmic artery (fig. 239, p. 384): *a*, optic nerve; *b*, superior oblique muscle, divided a little way behind its pulley; *c*, lachrymal gland lying upon the eyeball; *d*, inferior oblique muscle; *e*, foramen rotundum; *f*, maxillary sinus, opened externally: I, cavernous sinus, being joined by the common trunk of the ophthalmic veins; 1, supraorbital vein, joining the angular below and communicating behind (in this case by a long branch) with the superior ophthalmic vein; 2, inferior ophthalmic vein; 3, posterior ciliary veins; 4, 4, anterior and posterior ethmoidal branches, joining the superior ophthalmic vein; 5, frontal vein; 6, in front of the maxillary sinus, infraorbital vein; 6, in the orbit, communication of the inferior ophthalmic vein with the pterygoid plexus; II, facial vein; 7, deep facial from the pterygoid plexus; 8, 8, 8, nasal branches; 9, 10, angular vein; III, temporo-maxillary trunk, formed by the union of IV, the temporal and V, the internal maxillary veins; 11, meningeal branch; 12, inferior dental; 13, 14, muscular, alveolar and communicating branches; 15, placed in the spheno-maxillary fossa above the spheno-palatine vein; only a few branches of the pterygoid plexus are represented.

which correspond generally to the arteries of the same name. The veins from the eyeball are called anterior and posterior ciliary. The *anterior ciliary veins* are small and accompany the corresponding arteries; perforating the sclerotic coat close to the cornea, they join the muscular branches of the ophthalmic veins. The *posterior ciliary veins*, of larger size, are four or five in number, emerge from the eyeball about midway between the cornea and the entrance of the optic nerve, and end partly in the superior, partly in the inferior ophthalmic vein.

The **inferior ophthalmic vein** is formed by the union of the lower posterior ciliary veins with some branches from the muscles, and passes backwards near the floor of the orbit to open also into the cavernous sinus, either separately or in common with the superior ophthalmic vein. It sends a communicating branch downwards through the spheno-maxillary fissure to the pterygoid plexus, and sometimes this offset forms the chief or sole termination of the vein.

## VEINS OF THE DIPLOE.

The veins of the diploe of the cranial bones are only to be seen after the pericranium is detached, and the external table of the skull carefully removed by means of a file. Lodged in canals hollowed in the substance of the bones, their branches form an irregular network, from which a few larger vessels issue. These are directed downwards at different parts of the cranium, and terminate, partly in the veins on the outer surface of the bones, and partly in the sinuses of the interior of the skull. According to Breschet there are four such veins on each half of the cranium, viz., a frontal, an occipital, and two temporal.

Fig. 294.

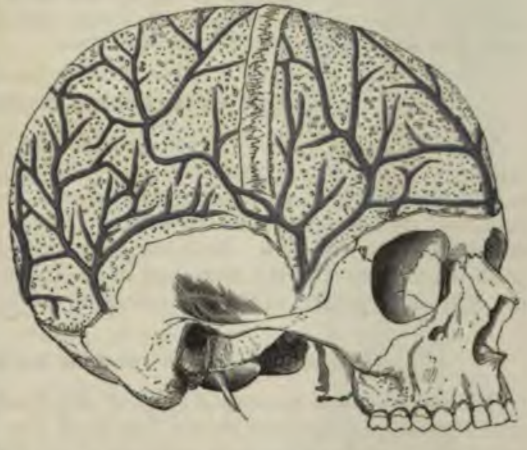


Fig. 294.—VEINS OF THE DIPLOE OF THE CRANIAL BONES (after Breschet). ½

The external table has been removed from the greater part of the calvaria so as to expose the diploe and the veins which have been injected: 1, a single frontal vein; 2, 3, anterior temporal vein; 4, posterior temporal; 5, occipital vein of the diploe.

The *frontal* is small, and issues by an aperture at the supraorbital notch to join the supraorbital vein. There is often only one frontal vein present.

The *temporal* are distinguished as anterior and posterior. The *anterior* is contained chiefly in the frontal bone, but may extend also into the parietal; it opens externally into a deep temporal vein, through an aperture in the great wing of the sphenoid, and internally into the spheno-parietal sinus. The *posterior* ramifies in the parietal bone, and passes through an aperture at the lower and hinder angle of that bone, or through the mastoid foramen, to the lateral sinus.

The *occipital* is the largest of all, and opens either externally into the occipital vein, or internally into the torcular Herophili or the lateral sinus. Its ramifications are confined especially to the occipital bone.

### EMISSARY VEINS.

The emissary veins are vessels which pass through apertures in the wall of the cranium and establish communications between the sinuses and the veins of the exterior of the skull. They vary much in size in different individuals, and some of them are not always present. The following vessels may be included in this group, viz. :—

(*a*) The *mastoid emissary* is the largest and most constant of these veins; it passes through the mastoid foramen between the lateral sinus and the outermost occipital, or less frequently the posterior auricular vein.

(*b*) The *parietal emissary*, occupying the parietal foramen and connecting the superior longitudinal sinus with the veins of the scalp, is usually of small size, and is frequently wanting on one or both sides.

(*c*) The *condylar emissary* is also inconstant; it passes from the lateral sinus through the posterior condylar foramen to the plexus surrounding the cervical vertebræ.

(*d*) A minute *occipital emissary* (Henle) is sometimes present, passing from the torcular Herophili, through a foramen which opens on the external occipital protuberance, to one of the occipital veins.

(*e*) Two or three small veins descend from the cavernous sinus through the foramen ovale, and others through the fibrous tissue in the foramen lacerum, to the pterygoid and pharyngeal plexuses.

(*f*) A small plexus, prolonged from the cavernous sinus, accompanies the internal carotid artery in the carotid canal, and opens below into the internal jugular vein (Rektorzik).

(*g*) A venous ring surrounds the hypoglossal nerve as it enters the anterior condylar foramen, and communicates internally with the occipital sinus, externally with the deep veins of the neck (Luschka).

## VEINS OF THE UPPER LIMB.

The veins of the upper limb are divisible into two sets, the superficial, which are placed between the fascia and the skin, and the deep, which accompany the arteries. The superficial veins are much larger than the deep, and take a greater share in returning the blood, especially from the distal portion of the limb. Both sets are provided with valves, and these are more numerous in the deep than in the subcutaneous veins. Valves are constantly present at the entrance of branches into the main vessels.

### SUPERFICIAL VEINS OF THE UPPER LIMB.

The two principal cutaneous veins of the forearm, the radial and the posterior ulnar, commence on the dorsum of the hand by a plexus into which the branches from both surfaces of the fingers empty themselves. Two smaller veins, the median and the anterior ulnar, ascend on the front of the forearm; and at the bend of the elbow all these vessels become connected so as to give rise to two trunks, the basilic and cephalic veins, which are continued up the arm.

The **radial vein** takes origin from the outer part of the plexus on the back of the hand, and is also joined at the upper end of the first interosseous space by a communicating branch of considerable size from the venæ comites of the deep palmar arch (Braune). It ascends along the outer border of the forearm, receiving numerous branches in its course, and at the bend of the elbow, in the hollow on the outer side of the biceps muscle, it unites with the median-cephalic division of the median vein to form the cephalic vein.

Fig. 295.

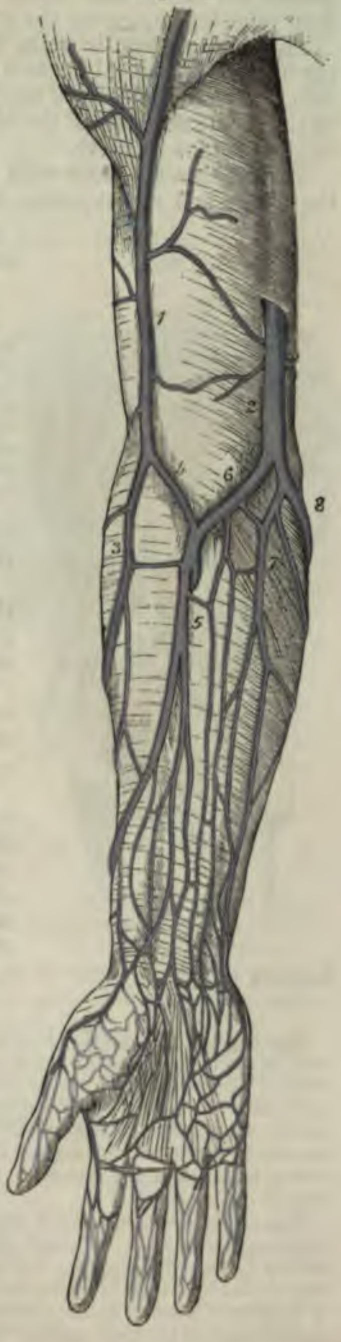


Fig. 295.—The superficial veins of the upper limb, from before (the arrangement of the veins of the hand after Braune). (G. D. T.). ¼

1, cephalic vein; 2, basilic; 3, radial; 4, median-cephalic; 5, median, receiving a large branch from the outer side of the wrist, and being joined near its division by the deep median vein; 6, median-basilic; 7, anterior ulnar; 8, posterior ulnar vein.

The **posterior ulnar vein** commences in the inner part of the dorsal plexus of the hand, and also receives a communicating branch issuing behind the abductor minimi digiti muscle from the deep veins of the palm (Braune). It proceeds along the posterior aspect of the ulnar border of the limb, lying on the surface of the flexor carpi ulnaris muscle, and just below (occasionally above) the internal condyle of the humerus turns forwards to join the median-basilic division of the median vein, thus giving rise to the basilic vein.

The **anterior ulnar vein,** much smaller than the posterior, ascends along the inner part of the front of the forearm, and at the bend of the elbow either joins the posterior ulnar or opens separately into the median-basilic vein.

The **median vein** is generally of small size, and results from the union of two or three vessels which pass upwards from a fine plexus in the palm of the hand, receiving other branches in the forearm and communicating freely on either side with the radial and ulnar veins; but not unfrequently it is large and forms the principal outlet of the dorsal plexus of the hand on the outer side, in which case the radial vein is proportionally reduced in size. It ascends to the hollow in front of the elbow, and there terminates by dividing into the median-basilic and median-cephalic veins, which diverge upwards from each other, lying one on each side of the prominent tendon of the biceps muscle. Close to its bifurcation this vessel receives a short wide branch, the *deep median vein,* which pierces the fascia, and forms a communication between it and the deep veins accompanying the arteries.

The **median-basilic vein,** usually the larger of the two divisions of the median, is directed inwards to join the commencement of the basilic vein. It passes in front of the brachial artery, from which it is separated by the semilunar fascia of the biceps, and it is crossed by branches of the internal cutaneous nerve.

The **median-cephalic vein** inclines outwards in the hollow between the biceps and the supinator longus muscles, passing in front of the musculo-cutaneous nerve, and joins the radial to form the cephalic vein.

Fig. 296.

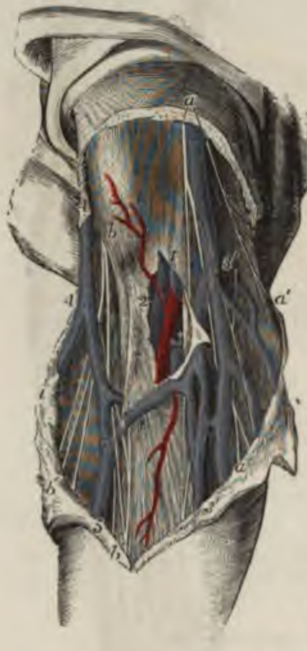


Fig. 296.—THE SUPERFICIAL VEINS AT THE BEND OF THE ELBOW (from R. Quain). $\frac{1}{3}$

The full description of this figure will be found at p. 410. At 1, the fascia is opened in front of the brachial artery and its accompanying veins; the inner vena comes has been divided, the outer, marked 2, is entire; +, median nerve; 3, basilic vein; 3', 3', ulnar veins; 4, cephalic vein; 4', radial vein; 5, 5, median vein; 5 to 4', median-cephalic; 5 to 3', median-basilic.

The **basilic vein,** the largest of the veins of the arm, ascends in the groove on the inner side of the biceps muscle, lying internal to the situation of the brachial artery; it perforates the fascia somewhat below the middle of the arm, and is continued upwards into the axillary vein.

The **cephalic vein** is directed upwards in the groove along the outer border of the biceps muscle, and then between the pectoralis major and the deltoid; finally dipping in between the last two muscles, it crosses the first part of the axillary artery, and opens into the axillary vein between the upper border of the pectoralis minor and the clavicle.

**Varieties.**—The superficial veins of the forearm are subject to great variation, both in the disposition and size of their trunks, and in their arrangement at the bend of the elbow. The *radial vein* may be very small or even absent, and in such cases the *cephalic vein* may also be wanting, the branches from the outer side of the forearm being collected into the median vein, which is continued directly into the median-basilic. It occasionally happens that the *anterior ulnar vein* is larger than the posterior. The *median-basilic vein* is not unfrequently double.

The *cephalic vein* sometimes passes up over the clavicle and terminates in the external jugular vein; or these two vessels may be united by a communicating branch (*jugulo-cephalic*) in this situation. In two cases this communicating branch has been seen to perforate the bone (Allen Thomson). The cephalic vein is occasionally found passing backwards between the subclavius muscle and the clavicle to join the lower end of the subclavian vein.

### DEEP VEINS OF THE UPPER LIMB.

The brachial artery and its various branches in the arm, forearm and hand, are each accompanied by two veins, named *venæ comites.* These companion veins lie one on each side of the corresponding artery, and are connected with each other at intervals by short cross branches, which in some places closely surround the artery. Their distribution so nearly corresponds with that of the arteries, that they need not be more particularly described.

The **brachial veins,** or venæ comites of the brachial artery, terminate near the lower margin of the subscapularis muscle by joining the axillary vein; not unfrequently, however, the inner one unites with the basilic vein soon after that vessel passes beneath the fascia.

Fig. 297.

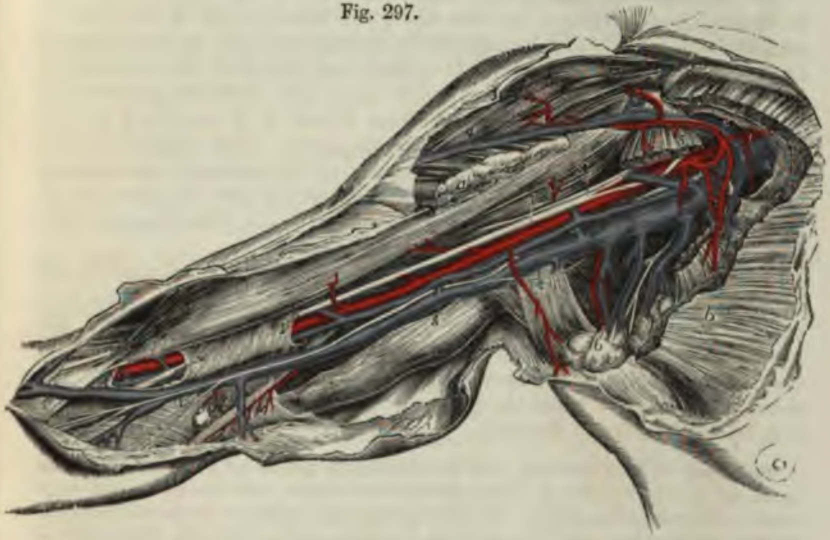


Fig. 297. THE BLOOD-VESSELS OF THE AXILLA AND ARM FROM THE INNER SIDE (R. Quain). 1/3

The detailed description of this figure will be found at p. 409. The following numbers indicate the principal veins :—2, axillary vein; 3, 3, basilic vein; 3′, median basilic; 4, 4′, cephalic vein; 6, alar thoracic and subscapular; 7, one of the brachial veins.

Between the several veins of the upper limb numerous communications exist in their whole course. Thus, those which lie beneath the integument are freely connected to each other by cross branches in the hand and forearm. Not only are the veins in each pair of venæ comites united by short transverse vessels crossing the artery which they accompany, but also those accompanying different arteries have frequent connections with each other. Lastly, the subcutaneous and the deep veins communicate freely, especially in the neighbourhood of the joints. This general anastomosis ensures the continuance of the circulation during muscular action in the frequent and varied motions of the limb.

The **axillary vein** is of large size and collects all the blood returning from the upper limb. It is formed by the continuation upwards of the basilic vein of the arm, and extends, like the corresponding artery, from the lower border of the teres major muscle to the outer margin of the first rib. It is placed on the inner side of the axillary artery and has similar relations to the surrounding muscles.

*Lateral tributaries.*—The axillary vein receives in its course the several veins corresponding to the branches of the axillary artery, viz., the two *circumflex*, *subscapular*, *long thoracic*, *alar thoracic*, *acromio-thoracic* (opening in common with the cephalic vein) and the *superior thoracic veins*; at the lower border of the subscapularis muscle it is joined by one or both of the brachial venæ comites, and near its termination by the cephalic vein.

The **subclavian vein** is the continuation of the axillary, and extends from the outer margin of the first rib to the inner border of the anterior scalenus muscle, where it terminates by uniting with the internal jugular to form the innominate vein. It crosses over the first rib and behind the clavicle, being placed at a lower level and therefore pursuing a less arched course than the artery, from which it is separated by the anterior scalenus muscle and the phrenic nerve. The subclavian vein is joined, usually close to the outer border of the anterior scalenus, by the external jugular vein, and it has constantly a pair of valves placed immediately outside the entrance of the latter vessel (Struthers, *op. cit.*, p. 244).

The wall of the subclavian vein adheres closely to the fascial sheath by which it is invested, and this being intimately connected in front with the costo-coracoid membrane and the back of the clavicle (p. 196), the vessel becomes expanded when the shoulder is carried forwards. Hence care should be taken in operations about the root of the neck or the shoulder in order to avoid the danger of air being drawn into the circulation by movements of the limb.

**Varieties.**—The subclavian vein is occasionally placed at a higher level than usual as it curves inwards, rising above the clavicle into the neck, and overlapping the subclavian artery. It has also been seen in rare cases passing between the subclavius muscle and the clavicle (Luschka), lying with the artery behind the anterior scalenus, changing places with the artery, or, lastly, dividing into two parts, which were placed, one in front of, the other behind the anterior scalenus (Luschka). It often receives separately the anterior jugular, the suprascapular or the transverse cervical vein; occasionally the cephalic vein. Other unusual tributaries that have been met with are the brachial venæ comites (W. Krause), and on the left side a bronchial vein (M. J. Weber).

## AZYGOS VEINS.

The azygos veins are longitudinal vessels resting against the thoracic portion of the spinal column, and formed by the union of the veins corresponding to the arteries of the intercostal spaces. In the lower part of the thorax the two veins of opposite sides are disposed symmetrically, but higher up the blood gathered from most of the veins of the left side is poured into the trunk on the right, which becomes enlarged and unsymmetrical, and has on that account received the name of large or right azygos, while the united vessels from the corresponding parts on the left side constitute the small or left azygos veins.

The **right** or **large azygos vein** (vena azygos major) commences in the abdomen, generally by an anastomotic vessel (*ascending lumbar vein*) which connects together the several lumbar veins, and establishes a communication below, either directly or indirectly, with the common iliac vein. It is also joined in many cases by a branch which opens distally into the inferior vena cava, or into the renal vein, and occasionally it takes its origin solely in this way. Passing from the abdomen into the thorax through the aortic opening in the diaphragm, or to the outer side of that opening through the fibres of the right crus, the azygos vein ascends on the bodies of the dorsal vertebræ to the level of the fifth rib, where it arches forwards over the root of the right lung, and then opens into the superior vena cava, immediately above the point at which that vessel perforates the pericardium. When passing through the opening in the diaphragm, this vein is accompanied by the thoracic duct, both being situated on the right side of the aorta. In the thorax, maintaining the same position with respect to the duct and the aorta, it passes in front of the intercostal arteries, and is covered by the pleura. It receives the intercostal veins of the right side, with the exception of that from the first space, the upper two or three of these vessels being united into a short common trunk which is known as the *superior intercostal vein* (p. 493), and which opens into the commencement of the arch of the azygos vein. It is also joined by the left azygos veins, by the right bronchial vein, and by several small œsophageal, pericardial, and posterior mediastinal veins.

Fig. 298.

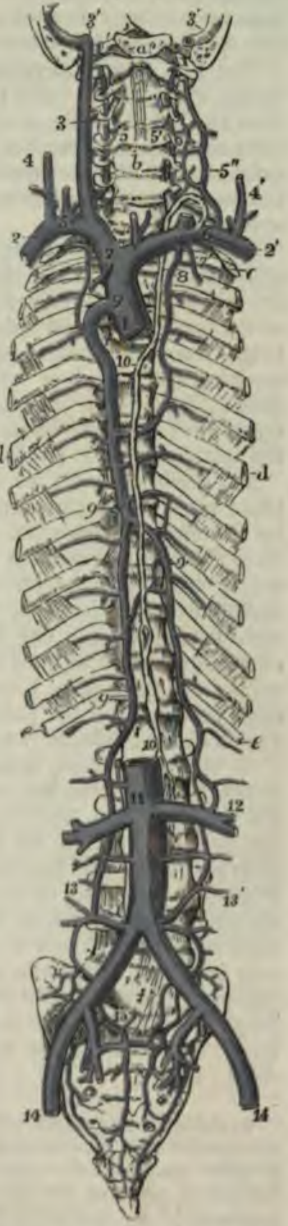


Fig. 298.—Sketch of the principal systemic venous trunks, showing the azygos veins. (A. T). $\frac{1}{5}$

For the detailed description of this figure see p. 491. The following indications relate to the accompanying part of the text: 8, left superior intercostal vein, continued below into the left upper azygos vein; the superior intercostal vein of the right side is seen passing downwards into the large azygos vein; 9, 9, 9, large azygos vein; 9′, left lower azygos vein; 10, thoracic duct; 11, inferior vena cava; 12, union of a branch of the left lower azygos with the left renal vein; 13, 13′, right and left ascending lumbar veins, continued upwards into the corresponding azygos veins; 15, union of lumbar, iliolumbar, and sacral veins.

The **left lower** or **small azygos vein** (v. hemiazygos) commences as the ascending lumbar vein of the left side, or frequently by a communication with the corresponding renal vein, seldom with the suprarenal or spermatic. It enters the thorax through the left crus of the diaphragm and ascends upon the spine, in front of the lower intercostal arteries, to the level (most frequently) of the ninth dorsal vertebra, where it crosses to the right behind the aorta and opens into the large azygos vein. It receives the intercostal veins from the lower three or four spaces of the left side, and some small branches from the mediastinum.

The **left upper azygos vein** (v. hemiazygos accessoria) is formed by the union of the veins from four or five intercostal spaces, generally from the fourth to the seventh or eighth inclusive, and it receives also some mediastinal branches and the left bronchial vein. It communicates above with the superior intercostal vein, and below it opens into the large azygos vein, either separately or in common with the left lower azygos vein.

The *intercostal veins* are single vessels lying in the intercostal spaces above the arteries, which they follow closely in their ramifications. They are joined by large posterior branches, collecting blood from the muscles of the back, the dorsal spinal plexus and the spinal canal, and by small twigs from the bodies of the vertebræ, before terminating in the superior intercostal or azygos veins. The vein from the first space passes forwards in company with the superior intercostal artery, and opens into the innominate vein or one of its branches, most frequently the vertebral (B. G. Morison, Journ. Anat., xiii., 346).

The *bronchial veins* are of small size and return only a portion of the blood conveyed to the lungs by the bronchial arteries. They are formed by the union of branches from the larger bronchial tubes, as well as from the other structures of the lung, and issue at the hilus of that organ, where they receive other twigs from the lower part of the trachea and from a fine plexus in the posterior mediastinum. The vein of the right side opens into the large azygos vein near its termination ; that of the opposite side ends in the left upper azygos vein. The minute veins from the smaller bronchial tubes, and some of those from the larger ones, terminate in the pulmonary veins, as do also several branches from the mediastinal plexus (Zuckerkandl, Wiener Sitzungsber., 1881).

As the azygos veins communicate below with the inferior vena cava or some of the branches of that vessel, while they terminate above in the superior cava, they form a supplementary channel by which blood can be conveyed from the lower part of the body to the heart in cases of obstruction of the inferior trunk. There is generally a valve, most frequently consisting of two segments, in the arch or at the upper end of the ascending portion of the large azygos vein, but in the majority of cases it is not sufficient to close the vessel completely. In rare instances only is a valve present in the left lower azygos vein at or near its termination. The intercostal veins from the upper spaces have valves more frequently than not at their openings into the azygos veins ; in the lower intercostal veins valves are seldom present (Gruber, Arch. f. Anat., 1866).

**Varieties.**—The azygos veins of the left side present many varieties both in the number of intercostal veins which each receives, and in the manner in which they are connected with the large azygos vein. Two or three of the middle intercostal veins of the left side frequently unite into a short intermediate trunk, which passes directly into the large azygos vein ; or the left upper azygos vein may be absent, the intercostal veins which usually form that vessel being continued across the spine and opening independently into the main stem. The left superior intercostal and upper azygos veins are sometimes represented by a single vessel, which may join either the corresponding innominate vein above, or the large azygos vein below. Occasionally all the intercostal veins of the left side are collected into a longitudinal trunk which terminates in the left innominate vein, the arrangement corresponding to that on the right side; and, on the other hand, instances are sometimes met with in which there is only a single azygos vein ascending on the front of the spine and receiving the intercostal veins of both sides. Transposition of the azygos veins is recorded by Gruber, the larger vessel being placed on the left side, receiving the smaller right veins, and then arching forwards over the root of the left lung to open into the left end of the coronary sinus of the heart, thus resembling the condition which is normal in the sheep and some other animals. The foregoing varieties are readily explained by reference to the mode of development of these vessels (see Vol. II).

In several cases the inferior vena cava has been seen continued into the azygos vein, which is then of course extremely large (see varieties of the inferior cava), and the spermatic vein or, on the left side, the renal and suprarenal veins have also been observed terminating in the same manner.

## VEINS OF THE SPINE.

The veins of the spine form plexuses extending along the whole length of the column, and may be divided into the following sets: 1, the dorsal, placed deeply in the vertebral grooves; 2, the veins of the bodies of the vertebræ; 3, the anterior longitudinal, lying within the canal at the back of the bodies of the vertebræ; 4, the posterior longitudinal, also situated within the canal, along the fore part of the arches of the vertebræ; and 5, the veins of the spinal cord. There are likewise branches of communication, some of which unite the several sets with one another, while others bring them into connection with the general venous system. The veins of the spine have no valves. (See Breschet, "Les Veines du Rachis," and "Le Système Veineux," Paris, 1829; Cloquet, "Anatomie descriptive," &c.)

The **dorsal spinal veins** are derived from the muscles and integument of the back, and form a plexus over the arches of the vertebræ. The largest tributaries pass forwards by the side of the interspinous ligaments, proceeding in many cases from a median longitudinal vessel placed over the spinous processes of several vertebræ. Offsets from the plexus perforate the ligamenta subflava to join the posterior longitudinal veins within the spinal canal, and at the outer part of the vertebral groove other veins are given off, which pass forwards between the transverse processes and open into the posterior branches of the intercostal and lumbar veins, or in the neck, where the plexus is most developed, into the vertebral vein.

The **veins of the bodies of the vertebræ** are comparatively large vessels contained in the canals within these bones, the arteries which accompany them being very small. They anastomose on the front of the vertebræ with the veins in that situation, and the trunk of each, having reached the spinal canal through the single or double foramen on the posterior surface of the body of the vertebra, opens into the corresponding transverse branch uniting the anterior longitudinal veins.

The **anterior longitudinal spinal veins** are two large plexiform vessels which extend the whole length of the spinal canal, lying behind the bodies of the vertebræ, one along each edge of the posterior common ligament. These vessels are dilated opposite the bodies of the vertebræ, where the right and left veins are connected by large transverse branches placed between the posterior common ligament and the bones, and constricted over each intervertebral disc, at which point an offset is sent outwards through the corresponding intervertebral foramen. Superiorly, the anterior spinal veins communicate with the basilar sinus through the foramen magnum, and form, with the posterior longitudinal veins and the lower end of the occipital sinus, a venous ring in the substance of the dura mater round that opening.

Fig. 299.

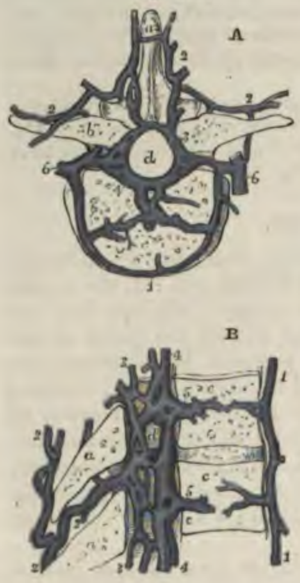


Fig. 299, A and B.—Horizontal and sagittal sections of lower dorsal vertebræ, showing the external and internal veins of the spine (after Breschet). ⅔

*a*, spinous process; *b*, transverse process; *c*, body; *d*, spinal canal; 1, external veins of the body; 2, dorsal spinal veins, communicating with the internal and forming a plexus over the laminæ and processes; 3, posterior, and 4, anterior internal plexus of veins of the spinal canal; 5, internal veins of the body joining the anterior spinal veins; 6, posterior branches of the intercostal veins.

The **posterior longitudinal spinal veins,** also two in number, are contained in the loose tissue between the dura mater and the posterior wall of the spinal canal. They are often much broken up in parts of their course, and they communicate with one another by numerous cross branches on the anterior surface of the arches of the vertebræ, with the dorsal spinal veins by branches perforating the ligamenta subflava, and with the occipital sinus by branches which ascend through the foramen magnum. From the plexus thus formed offsets pass outwards to the intervertebral foramina, where they join the similar branches given off by the anterior longitudinal veins.

The **veins of the spinal cord** are of small size and run with a tortuous course in the substance of the pia mater, where they form a network with elongated meshes. They are larger below than above, and one vessel, which exceeds the others in size, lies beneath the anterior spinal artery over the anterior median fissure of the cord. They communicate with the veins of the spinal canal by means of branches which accompany the nerves to the intervertebral foramina, and at the upper end of the cord they unite to form two or three small trunks which join the inferior cerebellar veins, or open into the inferior petrosal sinuses.

From a consideration of the connection and arrangement of the different parts of these complex veins, it would appear that the main currents of the blood flow through them horizontally in the rings that are formed by the transverse branches between the longitudinal veins, and the offsets proceeding from the latter to the intervertebral foramina. The veins issuing from the spinal canal open, according to the region in which they are placed, into the vertebral veins, into the posterior branches of the intercostal and lumbar veins, and into the lateral sacral veins.

## INFERIOR VENA CAVA.

The inferior or ascending vena cava returns the blood from the lower limbs and abdomen. It begins at the junction of the two common iliac veins in front of the fifth lumbar vertebra, and thence ascends along the right side of the aorta, being covered by the duodenum, pancreas, and commencement of the portal vein, to the posterior border of the liver; there it becomes embedded in a deep groove, not unfrequently a canal, in that organ, and inclines forwards to reach its opening in the tendon of the diaphragm, to the margin of which the wall of the vessel is firmly united. After perforating the diaphragm, it is enclosed for a very short distance in a fold of the serous layer of the pericardium, and then terminates by entering the right auricle of the heart. A semilunar valve, known as the *valve of Eustachius,* is situated over its entrance into the auricle, but this, as explained in the description of the heart, is only the vestige of a fœtal structure, variable in size, and without influence in preventing reflux of the blood.

Tributaries.—Besides the common iliac veins, the inferior vena cava receives the following:—

1. The **lumbar veins** (fig. 298, p. 513) correspond in number with the arteries of the same name. They are formed by the junction of *anterior* branches from the wall of the abdomen, where they communicate with the epigastric and other neighbouring veins, and *posterior* branches, of larger size, which receive tributaries from the muscles of the back, the dorsal spinal plexus, and the spinal canal. Passing forwards upon the bodies of the vertebræ, behind the psoas muscle, and on the left side also behind the aorta, they terminate by opening into the back of the inferior vena cava. Two of the vessels, either of the same or of opposite sides, may join together into a single trunk before their termination. The lumbar veins of each side communicate with one another by means of branches which cross in front of the transverse processes, and in this way a longitudinal vessel is formed, called the *ascending lumbar vein,* which connects together more or less completely the lateral sacral, ilio-lumbar, common iliac, and lumbar veins, and is continued upwards into the corresponding azygos vein.

2. The **spermatic veins** (in the male) proceed upwards from the testicle and epididymis, and form in the spermatic cord a thick plexus of convoluted vessels known as the *spermatic* or *pampiniform plexus.* Passing through the inguinal canal into the abdomen, in company with the spermatic artery, the branches from this plexus join into two or three veins, and these again unite into a single vessel which ascends beneath the peritoneum, on the surface of the psoas muscle, and opens on the right side into the vena cava, on the left into the renal vein. The spermatic veins sometimes bifurcate before their termination, and in this case one branch may enter the vena cava, the other the renal vein.

In the female the **ovarian veins** have the same general course as the ovarian arteries; they form a plexus near the ovary (*ovarian* or *pampiniform plexus*) in the broad ligament, and communicate freely with the uterine plexus.

Imperfect valves are present in the spermatic veins below the external abdominal ring; and in exceptional cases they have been seen in the ovarian veins. There is also in most cases a valve at the termination of each spermatic or ovarian vein, but this is not unfrequently absent on the left side, and then a valve will generally be found in the renal vein not more than a quarter of an inch from the entrance of the former vessel (Rivington, Journ. Anat., vii., 163).

**3.** The **renal** or **emulgent veins** are short but wide vessels which issue from the hilus of the kidney, and pass inwards in front of the corresponding arteries to join the vena cava nearly at a right angle, the left usually a little higher up than the right. The vein of the left side is also longer than the right, and passes in front of (rarely behind) the aorta. The renal veins receive small branches from the suprarenal bodies, and the left is joined also by the spermatic and capsular veins of the same side. Valves are occasionally present in the renal veins or in some of their branches (Rivington).

**4.** The **capsular** or **suprarenal veins** are, relatively to the organs from which they arise, of considerable size. On the right side the vein ends in the vena cava, on the left in the renal vein.

**5.** The **hepatic veins** return the blood conveyed to the liver by the portal vein and the hepatic artery. They converge to the groove in which the inferior vena cava lies, and are collected mainly into two or three large trunks which open obliquely into that vessel. There is also a variable number of smaller branches which collect the blood from the adjacent portions of the gland and pass directly into the vena cava. The hepatic veins have no valves ; but, owing to their oblique entrance into the vena cava, a semilunar fold is formed at the lower border of the orifice of each vein.

**6.** The **inferior phrenic veins** are two in number on each side, and follow the course of the arteries of the same name. On the left side these veins often join the suprarenal vein.

**Varieties.**—It occasionally happens that the left common iliac vein is continued upwards on the left side of the aorta, after having given off, in most of these cases, a connecting branch of variable size to the right vein at the usual place of junction. About the level of the second lumbar vertebra it receives the left renal vein, and then crosses in front of (very rarely behind) the aorta to join the right common iliac vein, which passes up in the usual place of the inferior vena cava. The vein on the left of the aorta in these cases is regarded by W. Krause as a persistent lower portion of the left cardinal vein of the fœtus. In rarer cases the inferior vena cava is placed in the lower part of its course on the left side of the aorta, and crosses over the latter vessel to gain its usual situation, after having been joined by the left renal vein. It is obvious that this condition would result from the foregoing variety if the vein of the right side were obliterated.

In cases of transposition of the viscera, without other abnormality (p. 356), the inferior vena cava is of course on the left side of the aorta throughout.

In a few instances the inferior vena cava, instead of ending in the right auricle of the heart, has been seen following the course of the right, or even of the left, azygos vein, passing through the diaphragm by the side of the aorta, and ascending through the posterior mediastinum, to join the superior vena cava, which therefore returns the blood from nearly the whole of the body. In these cases the hepatic veins do not join the inferior cava, but form a trunk which opens into the right auricle at the usual place of termination of that vessel. In this variety it may be supposed that the normal inferior cava has not been developed, and that the blood is returned from the lower part of the body by a persistent cardinal vein. (See the account of the development of the great veins in Vol. II.)

Supernumerary *renal veins* are occasionally met with, but not so frequently as supernumerary arteries ; and one of these vessels on the left side may open into the corresponding azygos vein, as may also the *spermatic* or *suprarenal vein*.

**The *hepatic veins* have been seen forming a trunk which opened independently into the right auricle (Hyrtl); and a single hepatic vein has been found to end in this way (Kadyi), or in the left auricle (Breschet), or in the right ventricle of the heart, where its orifice was guarded by a valve (Rothe).**

## COMMON ILIAC VEINS.

The common iliac veins are formed on each side by the confluence of the external and internal iliac veins. Extending from the base of the sacrum upwards to near the junction of the fifth with the fourth lumbar vertebra, at a point a little to the right of the middle line, the two common iliac veins unite to form the inferior vena cava. The right vein is shorter than the left, and is nearly vertical in its direction. The right vein is placed behind, and then to the outer side of its artery; while the left vein is to the inner side of the left common iliac artery, and then passes behind the right. These veins are usually destitute of valves, but in a few instances one has been met with (Friedreich).

LATERAL TRIBUTARIES.—The **ilio-lumbar vein** collects branches from the hinder part of the abdominal wall, from the muscles of the back, and from the spinal canal, and emerges from beneath the psoas muscle to enter the lower part of the common iliac vein. It communicates above with the lumbar, and below with the lateral sacral veins.

The **middle sacral veins,** two in number, ascend on the front of the sacrum with the middle sacral artery, and join above into a single vessel which opens into the left common iliac, or occasionally into the angle of union of the two large veins. They anastomose freely with the lateral sacral veins, and by smaller branches with the veins of the rectum.

**Varieties.—The common iliac vein is sometimes divided into two vessels for a portion of its extent. Absence of the common iliac vein of one or both sides has been met with by Gruber, the left external and internal iliac veins in one instance being continued upwards to enter the commencement of the inferior cava, and in another the two internal iliac veins being joined into a common trunk which unites with the right and left external iliac veins to form the vena cava (Virchow's Archiv., liv., 190).**

## VEINS OF THE LOWER LIMB AND PELVIS.

The veins of the lower limb are divisible into two sets, those of the one being deeply seated, those of the other running in the superficial fascia. All the veins of the lower limb are provided with valves, and these are more numerous than in the veins of the upper limb. The deep veins have more valves than the subcutaneous set.

### SUPERFICIAL VEINS OF THE LOWER LIMB.

Immediately beneath the integument on the dorsum of the foot there exists a network of veins receiving the branches from the toes and forming a more or less regular arch, from which issue two principal trunks, named the internal or long, and the external or short saphenous veins.

The **internal** or **long saphenous vein** extends from the ankle to within an inch and a half of Poupart's ligament. Taking rise from the inner part of the plexus on the dorsum of the foot, it passes upwards in front of the inner ankle, and then behind the inner border of the tibia, accompanied by the internal saphenous nerve. It inclines a little backwards as it passes the inner condyle of the femur, and ascending along the inner and fore part of the thigh, following the course of the sartorius muscle, it passes through the saphenous opening in the fascia lata to terminate in the femoral vein.

Fig. 300.

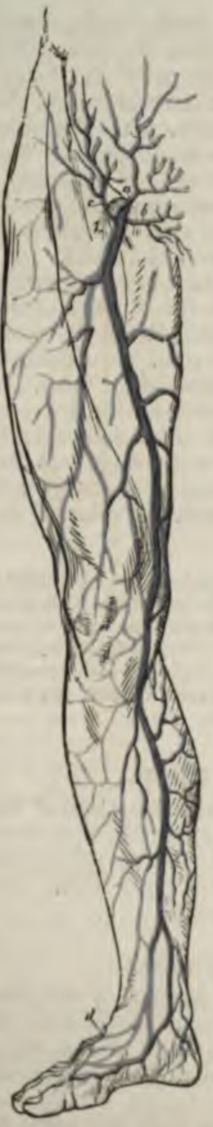


Fig. 300.—THE INTERNAL SAPHENOUS VEIN.

1, saphenous opening in the fascia lata; *a*, superficial epigastric vein; *b*, external pudic; *c*, superficial circumflex iliac; *d*, external or short saphenous beginning on the dorsum of the foot.

The internal saphenous vein communicates below the internal malleolus with the deep plantar veins, in the leg with the veins accompanying the anterior and posterior tibial arteries, and in the thigh one or more branches pass between it and the femoral vein. It is joined at its commencement by superficial branches from the inner part of the sole; in its course upwards by numerous cutaneous branches from the leg and thigh; and close to its termination by the *superficial circumflex iliac, superficial epigastric,* and *external pudic veins,* corresponding severally to the arteries of the same name, as well as in many cases by a large *anterior* branch which ascends in the thigh over the position of the femoral artery. There is also very frequently a *posterior* branch of considerable size, collecting blood from the inner and back parts of the thigh, and opening into the saphenous vein a little below its aperture in the fascia lata.

The **external** or **short saphenous vein**, smaller than the internal, proceeds from the outer end of the arch on the dorsum of the foot. It passes behind the outer ankle, and ascends in the leg along the outer border of the tendo Achillis, in company with the external saphenous nerve, and then over the interval between the heads of the gastrocnemius to the lower part of the popliteal space, where it perforates the deep fascia to end in the popliteal vein. Opposite the ankle and along the leg it communicates with the deep veins; and it receives superficial branches from the outer part of the foot and heel, and the back of the leg, as well as one which descends on the posterior surface of the thigh. A communicating branch passes from this vessel near its termination upwards and forwards to the internal saphenous vein, and sometimes the trunk itself follows this course, having no connection, or only a very small one, with the popliteal vein.

## DEEP VEINS OF THE LOWER LIMB.

The deep veins accompany the arteries and their branches, following exactly their distribution. Those below the knee, being for the most part disposed in pairs, and presenting the disposition described in the corresponding veins of the upper limb, are named the *venæ comites* of the vessels with which they are associated. The venæ comites of the arteries of the leg, namely, the **anterior** and **posterior tibial veins** (the latter having previously received the **peroneal**), unite near the lower border of the popliteus muscle, and form by their junction the popliteal vein.

Fig. 301.

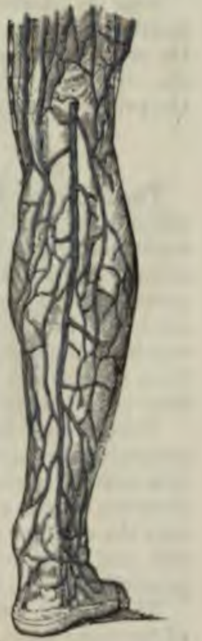


Fig. 301.—THE EXTERNAL SAPHENOUS VEIN.

The vein, commencing on the dorsum and outer side of the foot, is seen to pass up behind the outer ankle and to dip beneath the fascia in the popliteal space.

The **popliteal vein,** thus formed, receives smaller branches corresponding to the articular and muscular arteries, and the larger branch named the external saphenous vein. In its course upwards the vein is placed superficially to the popliteal artery, and it crosses that vessel gradually from the inner to the outer side. It passes with the artery through the opening in the adductor magnus, and becomes continuous with the femoral vein.

**Varieties.**—The union of the veins which form the popliteal is often farther up than usual, and the lower part of the artery is then accompanied by two veins. This arrangement in some rare cases extends to the entire length of the artery.

The **femoral vein** extends, like the artery which it accompanies, through the upper three-fourths of the thigh, and terminates at Poupart's ligament in the external iliac vein. Placed behind and at first somewhat to the outer side of the artery, it gradually inclines inwards, and on reaching Poupart's ligament lies on the inner side, on the same plane with the artery, from which it is separated only by a slight partition of the membranous sheath investing both vessels. In the lower part of its course, the vein receives the branches which accompany the offsets of the superficial femoral artery; in the upper part, the *deep femoral* (*profunda*) *vein* opens into it, having first received the venæ comites of the branches derived from the deep femoral artery; and near its termination it is joined by the internal saphenous vein. The femoral vein contains several valves, and one is always present at the entrance of the profunda vein. In many cases there is another valve between the latter point and Poupart's ligament (Friedreich, Morph. Jahrb., vii., 323).

**Varieties.**—The femoral vein occasionally pursues a course different from that of the artery along the thigh. Extending upwards from the popliteal space, the vein in such cases perforates the adductor magnus above the ordinary position, and, joining with the deep femoral vein, first approaches the femoral artery at the groin. The same vein is sometimes double in a small part, or more rarely in almost its whole length; and this condition, as well as the similar variety of the popliteal vein, may be explained as resulting from the enlargement of one of a pair of small veins which constantly accompany the main arterial trunk (Langer).

The **external iliac vein** is the continuation of the femoral vein from Poupart's ligament to the junction of the internal iliac vein, in the neighbourhood of the lumbo-sacral articulation. It is at first internal to the artery, but as it ascends it gradually inclines to the back of that vessel. It frequently contains one valve, very rarely two (Friedreich).

Near its commencement at Poupart's ligament, the external iliac vein receives the *deep circumflex iliac* and *epigastric veins*, corresponding to the arteries of the same name, and also a *pubic vein*, which ascends from the obturator vein in the thyroid foramen, and frequently constitutes the principal termination of the latter vessel.

### VEINS OF THE PELVIS.

The **internal iliac vein** is formed by the union of branches which accompany most of the branches of the internal iliac artery. The umbilical vein of the fœtus, however, which in the cord accompanies the corresponding arteries, diverges from these arteries within the body, and passes upwards to the liver. The internal iliac vein lies behind and somewhat to the inner side of the artery, and, after a short course upwards to the margin of the pelvis, joins with the external iliac vein, to form the common iliac. No valves are found in the trunk of the internal iliac vein, but they exist in its branches.

*Tributaries.*—The tributaries of the internal iliac vein correspond in general to the various branches of the internal iliac artery, with the exception that the internal pudic vein does not receive the main supply of blood from the dorsal vein of the penis, and that the ilio-lumbar veins open into the common iliac trunks. The visceral veins are remarkable for their size and frequent anastomoses, and form a series of plexuses, named *prostatic, vesical, hæmorrhoidal, vaginal,* and *uterine.*

The *gluteal, sciatic* and *obturator veins* agree closely with the arteries of the same name.

The *lateral sacral veins* form, by their communications with one another and with the middle sacral veins, a plexus over the anterior surface of the sacrum. They receive branches from the sacral canal through the anterior sacral foramina, and open at two or three points into the internal iliac vein.

The *internal pudic vein* commences as the *vein of the corpus cavernosum* and receives in its course backwards branches corresponding to the offsets of the artery in the perineum.

The *dorsal vein of the penis* commences by branches which issue from the glans penis and prepuce and form in the first instance two veins, one on each side of the middle line. These speedily unite and give rise to a single vessel which runs backwards between the two dorsal arteries, in the median groove on the upper surface of the penis, receiving on its way branches from the corpus spongiosum, and others from the corpora cavernosa and the skin of the organ. At the root of the penis the dorsal vein passes through the aperture below the subpubic ligament (p. 335), forming a communication on each side with the commencement of the pudic vein, and then divides into two branches which enter the right and left portions of the prostatic plexus. Each of these divisions is also con-

Fig. 302.

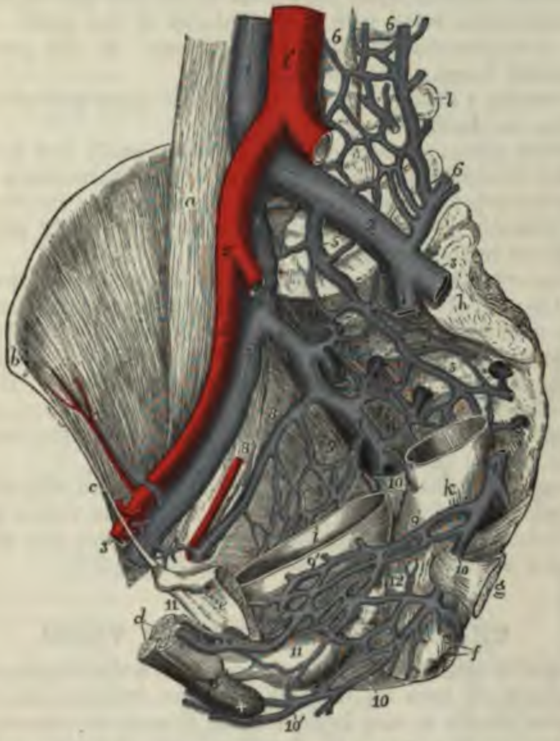


Fig. 302.—INTERNAL VIEW OF THE MALE PELVIS FROM THE LEFT SIDE, TO SHOW THE PRINCIPAL VEINS. (A. T.) $\frac{1}{3}$

The greater part of the pelvic wall of the left side, and the upper parts of the rectum and urinary bladder have been removed; the left common iliac and the right internal iliac arteries, and the left external and internal iliac veins have been cut short: *a*, right psoas magnus muscle; *b*, anterior superior iliac spine; *c*, Poupart's ligament; *d*, cavernous and spongy bodies of the penis divided near the root; +, bulb of the spongy body, above which is the membranous part of the urethra; *e*, left os pubis, sawn through close to the symphysis; *f*, anus; *g*, spine of the ischium with the small sacro-sciatic ligament; *h*, auricular surface of sacrum; *i*, bladder; *k*, rectum; *l*, transverse process of the fourth lumbar vertebra; 1, inferior vena cava; 1′, abdominal aorta; 2, 2, common iliac veins; 2′, right common iliac artery; 3, 3, external iliac veins; 3′, external iliac artery; 4, 4, internal iliac veins; 5, 5, middle sacral vein; 6, 6, ilio-lumbar and lumbar veins; 7, right gluteal and upper lateral sacral veins; 8, 8′, obturator vein and artery of the right side; 9, veins ascending from the vesical plexus on the right side; 9′, lower part of the vesical plexus on the left side; 10, placed on the small sacro-sciatic ligament, indicates on the right side the junction of the pudic and sciatic veins, on the left side the trunk of the pudic vein; 10′, perineal veins; 11, placed on the prostate, the left division of the dorsal vein of the penis joining the prostatic plexus, which is continued into the lower part of the vesical plexus; 12, placed on the lower part of the rectum, may indicate the position of the hæmorrhoidal plexus.

nected with the obturator vein of the same side by a considerable branch which ascends on the back of the pubis towards the thyroid foramen.

The *prostatic plexus* is formed mainly by the breaking up of the divisions of the dorsal vein of the penis, but it receives also smaller branches from the gland and the neighbouring muscles. It surrounds the base of the prostate, most thickly on its anterior and lateral aspects, and communicates below with the tributaries of the pudic vein, while above it is continuous with the vesical plexus. In old persons these veins generally become much enlarged.

In the female, a similar plexus surrounds the upper part of the urethra and receives the *dorsal vein of the clitoris.*

The *vesical plexus* consists of vessels which ramify over the whole of the bladder external to its muscular coat, being particularly large and numerous towards the base of the organ, where they are closely connected with the prostatic and hæmorrhoidal plexuses in the male, and with the vaginal plexus in the female.

The *hæmorrhoidal plexus* consists of large and copiously anastomosing veins in the wall of the lower part of the rectum, immediately underneath the mucous membrane. From it proceed *superior, middle,* and *inferior hæmorrhoidal veins* accompanying the arteries of the same name, and it communicates freely with the plexuses in front of it. The superior hæmorrhoidal vein being a branch belonging to the portal system, the hæmorrhoidal plexus forms a very free communication between the portal and general venous systems.

The *vaginal plexus,* surrounding the vagina principally in its lower part, communicates freely with the hæmorrhoidal and vesical plexuses.

The *uterine plexus* pours its blood in greatest part into the ovarian veins, and is not considerable except during pregnancy.

## THE PORTAL SYSTEM OF VEINS.

The portal vein differs from other veins of the body in being subdivided into branches at both its extremities. The branches of origin, by the union of which it may be said to be formed, are the veins of the chylopoietic viscera (stomach, intestine and pancreas) and of the spleen; the other branches, or those of distribution, undergoing ramification in the substance of the liver, convey to the capillaries of that organ the blood collected in the main trunk. This blood, together with that of the hepatic artery, after having served for the secretion of the bile and the nourishment of the liver, is withdrawn from that organ by the hepatic veins, and carried by them into the inferior vena cava. There are no valves in the portal vein or in any of its tributaries.

The **portal vein** or **vena portæ** is about three inches in length. Commencing behind the head of the pancreas by the junction of the splenic and superior mesenteric veins, it passes upwards and a little to the right, behind the first part of the duodenum and then between the layers of the small omentum, to the transverse fissure of the liver. In the omentum it is placed close behind the hepatic artery and the bile duct, and is accompanied by filaments of the hepatic plexus of nerves, as well as by numerous lymphatics, all these being surrounded by the loose connective tissue constituting the capsule of Glisson.

Near the right end of the transverse fissure, the vena portæ becomes somewhat enlarged (*sinus of the portal vein*), and immediately divides into two branches. That of the *right* side enters directly the substance of the corresponding lobe of the liver, and spreads out into branches, each of which is accompanied by an offset of the hepatic artery and of the hepatic duct. The *left* branch, which is smaller but necessarily longer, passes across to gain the left end of the transverse fissure, where it ramifies like the preceding branch. Opposite the fore part of the longitudinal fissure, the left branch of the portal vein is joined anteriorly by the so-called round ligament of the liver, the remains of the umbilical vein of the fœtus; and a little to the right of this, from its posterior aspect, another fibrous cord, the obliterated ductus venosus, passes backwards to join the inferior vena cava.

Fig. 303.

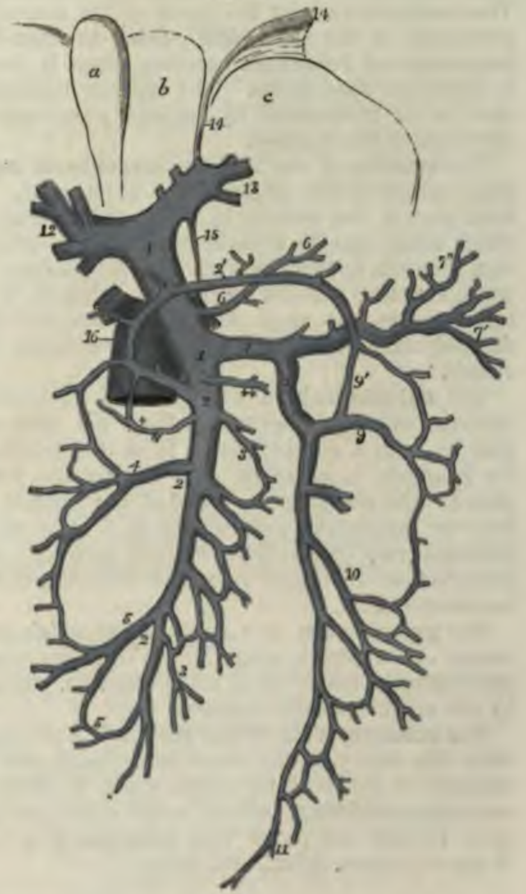


Fig. 303.—Diagrammatic outline of the portal vein and its tributaries. (A. T.) ¼

The liver is turned upwards, so as to present a portion of its under surface: *a*, gall-bladder; *b*, quadrate lobule; *c*, left lobe; 1, 1, portal vein; 2, 2, superior mesenteric vein; 2′, its middle colic branch, forming loops with the right and left colic veins; 3, 3, intestinal branches; +, pancreatico-duodenal branch; 4, right colic branch; 5, ileo-colic; 6, 6, coronary vein of stomach; + +, right gastro-epiploic; 7, splenic vein; 7′, its branches from the spleen; 7″, its branches from the stomach; 8, inferior mesenteric vein; 9, left colic branch; 9′, its communication with the middle colic; 10, sigmoid; 11, superior hæmorrhoidal; 12, the right, and 13, the left division of the portal vein in the transverse fissure of the liver; 14, 14, obliterated cord of the umbilical vein (round ligament of the liver); 15, obliterated cord of the ductus venosus; 16, part of inferior vena cava.

Tributaries.—The principal branches which by their union contribute to form the portal vein are the superior and inferior mesenteric.

and the splenic veins. It is also joined by the pyloric and coronary veins from the stomach, and sometimes by the cystic vein from the gall-bladder; but the latter vessel more frequently enters its right branch.

The **superior mesenteric vein** lies to the right side and somewhat in front of the artery of the same name. The distribution of its branches corresponds with that of the superior mesenteric artery, and it returns the blood from the several parts supplied by that vessel, viz., from the small intestine, and from the ascending and transverse parts of the colon. The trunk, formed by the union of its several branches, inclines upwards and to the right side, passing in front of the third part of the duodenum and behind the pancreas, where it joins with the splenic vein to form the vena portæ. The superior mesenteric vein is also joined, close to its termination, by the *right gastro-epiploic vein* from the great curvature of the stomach.

The branches of the **inferior mesenteric vein** correspond with the ramifications of the artery of the same name. They commence at the lower part of the rectum in the hæmorrhoidal plexus, and unite into a single vessel near the sigmoid flexure of the colon. From this point the vein proceeds upwards beneath the peritoneum, lying to the left of the aorta, and then passing behind the pancreas, it inclines to the right to terminate in the angle formed by the junction of the splenic and superior mesenteric veins, or in the adjacent part of either of these vessels.

The **splenic vein**, a vessel of large size, commences by five or six branches which issue separately from the hilus of the spleen, and soon join to form a single vessel. It is directed from left to right beneath the pancreas, in company with the splenic artery, below which it is placed. On reaching the front of the inferior vena cava it joins the superior mesenteric vein, nearly at a right angle. It receives *gastric* branches (vasa brevia) from the left extremity of the stomach, the *left gastro-epiploic vein*, some *pancreatic* branches, and frequently the inferior mesenteric vein.

The **pyloric vein** is a small vessel which accompanies the pyloric branch of the hepatic artery on the small curvature of the stomach, and opens into the lower end of the portal vein. It is sometimes represented by two or three smaller branches.

The **coronary vein of the stomach** is of considerable size, and runs with the artery of the same name along the small curvature of the stomach to the cardiac orifice, where it receives branches from the œsophagus, and then, turning to the right, passes across the front of the spine to join the portal vein immediately above the foregoing (W. J. Walsham, Journ. Anat., xiv., 399).

The name of *accessory portal veins* has been given by Sappey to a number of small vessels which collect blood from the areolar tissue and peritoneal folds around the liver, and partly open into branches of the portal vein, partly penetrate directly into the substance of the liver; through anastomoses formed by the radicles of these vessels the portal vein is put into direct communication with the phrenic and azygos veins. There are, moreover, constantly one or more small veins (*parumbilical*—Schiff) which descend from the left division of the portal vein, along the round ligament of the liver, towards the umbilicus, and form connections with the epigastric veins; and these vessels sometimes become much enlarged, setting up a more or less complete collateral circulation, in certain diseased conditions in which the branches of the portal vein within the liver are obstructed. The umbilical vein itself has occasionally been found patent for a variable distance below the liver, and receiving similar anastomosing branches. (Sappey, Mém. de l'Acad. de Méd., xxiii., 269; Luschka, "Anatomie des Bauches," 238; Champneys, Journ. Anat., vi., 417; Baumgarten, Centralbl. f. d. med. Wiss., xv., 721.)

Other communications between the portal and the general systemic veins are established by means of anastomoses formed by the veins of the pancreas, duodenum, colon and rectum with the parietal veins of the abdomen; and also through the œsophageal veins and the hæmorrhoidal plexus.

## 2.—ABSORBENT VESSELS.

The absorbent vessels are divisible physiologically into two sets: the *lacteals*, which convey the chyle from the alimentary canal to the thoracic duct; and the *lymphatics*, which take up the lymph from all the other parts of the body, and return it into the venous system. Anatomically considered, however, the lacteals are not different from the lymphatics, and may be regarded as the absorbents of the mucous membrane of the intestine. The larger lacteals and lymphatics are provided with numerous valves, which give them, when distended, a somewhat moniliform appearance; and both are connected in their course with *lacteal* or *lymphatic* glands.

The general anatomy of the absorbents being elsewhere detailed (Vol. II., p. 201) only their course and position remain to be here described. They are gathered into a right and a left trunk, which open into the angles of union of the subclavian and internal jugular veins. The large vessel of the left side traversing the thorax is named the *thoracic duct:* it receives not only the lympathics of its own side of the head and arm, and most of those of the trunk, but likewise the lymphatics of both lower limbs, and the whole of the lacteals. The short vessel of the right side is named the *right lymphatic duct,* and receives the lymphatics only of that side of the head and neck and upper part of the trunk.

### THORACIC DUCT.

The thoracic duct is the common trunk which receives the absorbents from both the lower limbs, from the abdominal viscera (except part of the upper surface of the liver), and from the walls of the abdomen, from the left side of the thorax, left lung, left side of the heart, and left upper limb, and from the left side of the head and neck. It is from fifteen to eighteen inches long in the adult, and extends usually from the second lumbar vertebra to the root of the neck. Its commencement, however, is often as low as the third lumbar vertebra; and in some cases as high as the first lumbar, or even the last dorsal vertebra. Here there is usually a dilatation of the duct, of variable size, which is called *receptaculum chyli* (Pecquet), and is the common place of junction of the lymphatics from the lower limb with the trunks of the lacteal vessels.

The lower part of the thoracic duct is generally wider than the rest, being about three lines in diameter; it lies at its commencement to the right side of or behind the aorta, and then ascends between that vessel and the right crus of the diaphragm to the thorax, where it is placed at first upon the front of the dorsal vertebræ, between the aorta and the large azygos vein. The duct runs upwards, gradually inclining to the left, and at the same time diminishing slightly in size, until it reaches the fourth dorsal vertebra, where, passing behind the arch of the aorta, it becomes applied to the left side of the œsophagus lying between that tube and the left subclavian artery. Continuing its course into the neck to the level of the seventh cervical vertebra, it changes its direction and turns outwards, at the same time arching downwards and forwards so as to describe a curve over the apex of the pleura, and then terminates on the outer side of the internal jugular vein, in the angle formed by the union of that vein with the subclavian. The diminution in the size of the duct as it ascends is such that at the fifth dorsal vertebra it is often only two lines in diameter, but above this point it again enlarges. The duct is generally waving and tortuous in its course, and is often alternately contracted and enlarged at irregular intervals.

Fig. 304.

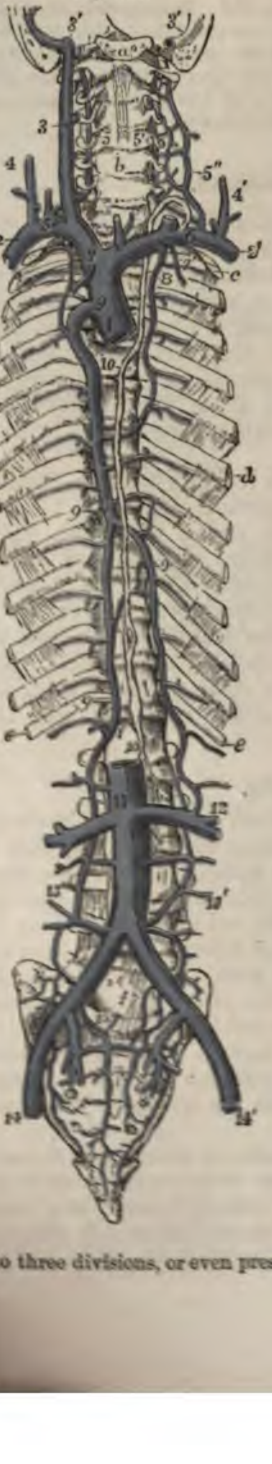


Fig. 304.—SKETCH OF THE THORACIC DUCT WITH THE PRINCIPAL SYSTEMIC VEINS. (A. T.) ¼

The full description of this figure will be found at p. 491.

10, 10, thoracic duct; the lower number is close to the receptaculum chyli; 6, on the left subclavian vein, marks the termination of the duct in the angle of union of the subclavian and internal jugular veins; 5, on the right subclavian vein, indicates the similar termination of the right lymphatic duct.

The thoracic duct has numerous double valves at short intervals throughout its whole course, the constrictions of their attachments giving a nodulated appearance to the vessel. They are more numerous in the upper part of the duct. At the termination of the duct in the veins there is a valve of two segments, so placed as to allow the contents of the duct freely to pass into the veins, but effectually preventing the reflux of either chyle or blood into the duct.

**Varieties.**—The thoracic duct is not always a single trunk throughout its whole extent; it is frequently divided for some distance into two vessels which afterwards unite, especially in the lower part of its course (normal according to Teichmann); sometimes it separates into three divisions, or even presents a plexiform arrangement, for a short distance.

very rare cases the duct is double throughout, the two canals opening into right and left innominate veins (W. Krause); or it is represented by two vessels which are placed one on each side of the aorta, and unite at the root of the neck into a single trunk (Nuhn, W. Turner). Cruikshank, in one case, found the duct triple or nearly so." In the neck, the thoracic duct often divides into two or three branches, which in some instances terminate separately in the great veins, and in other cases unite first into a common trunk; less frequently one of the branches passes across to the veins of the right side of the neck. In the lower animals the termination of the thoracic duct in the veins of the right side as well of the left is not uncommon. As a rare occurrence the trunk has been found passing upwards through the posterior mediastinum on the left side of the aorta Beale, G. D. T.). Several cases are recorded in which, the viscera not being transposed, the thoracic duct terminated in the veins of the right side, with a right aortic arch (Allen Thomson), with a root-origin of the right subclavian artery Fleischmann, Todd, J. M. Brown), or with a normal arrangement of the great arteries (Morrison Watson). In two instances the thoracic duct has been observed entering the large azygos vein (Wutzer, Arnold). (See Vol. II., p. 207.)

## RIGHT LYMPHATIC DUCT.

The right lymphatic duct is a short vessel, about a line or a little more in diameter, and from a quarter to half an inch in length, which receives the lymph from the absorbents of the right upper limb, the right side of the head and neck, the right side of the chest, the right lung and the right half of the heart, and from part of the upper surface the liver. It enters obliquely into the receding angle formed by the union of the right subclavian and internal jugular veins, where its orifice is guarded by a double valve. The vessels which usually unite to form this trunk, however, frequently terminate independently in the large veins.

## LYMPHATICS OF THE LOWER LIMB.

The lymphatics of the lower limb are arranged in a superficial and a deep series. Those of the superficial series, together with the superficial lymphatics of the lower half of the trunk, converge to the superficial inguinal glands, with the exception of a few which dip into the popliteal space. Those of the deep series enter the deep inguinal glands.

**The popliteal lymphatic glands,** usually very small, and four or five in number, surround the popliteal vessels, and are imbedded in a quantity of loose fat. They receive from below the deep lymphatics of the leg, and a few superficial ones which accompany the short saphenous vein; their efferent vessels ascend with the femoral vein to the groin.

**The superficial inguinal glands** vary much in number, amounting on an average to eight or ten: they are divisible into a superior or oblique and an inferior or vertical set. The oblique glands lie in the line of Poupart's ligament and receive lymphatics from the integument of the trunk, gluteal region, perineum, and genital organs; the vertical glands surround the upper end of the long saphenous vein, and extend two or three inches downwards along the course of that vessel; they receive the superficial lymphatics of the limb. The efferent vessels of the superficial inguinal glands perforate the fascia, a large number passing through the saphenous opening, and some enter the deep inguinal glands, while others are continued upwards with the deep vessels into the abdomen, and join the lymphatic glands which lie along the external iliac artery.

Fig. 305.

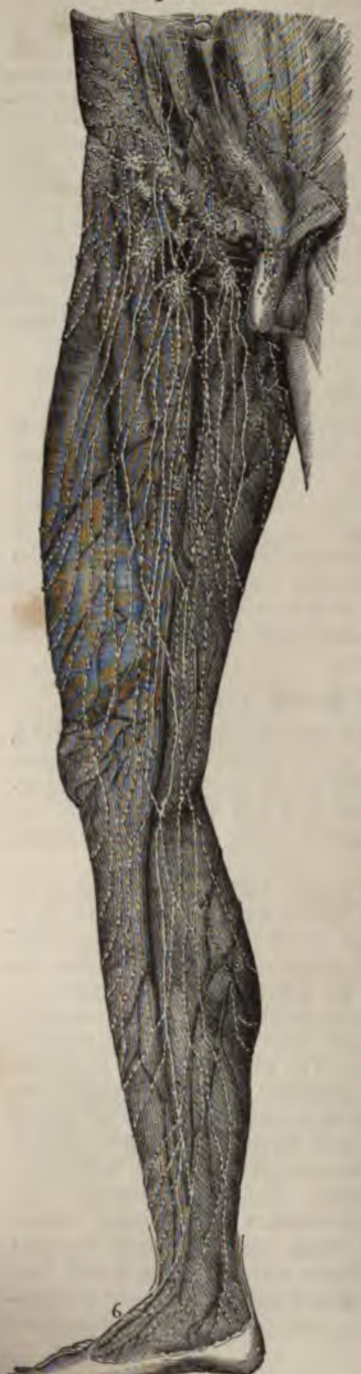


Fig. 305.—THE SUPERFICIAL LYMPHATIC VESSELS AND GLANDS OF THE LOWER LIMB, FROM THE FRONT AND INNER SIDE (founded on Mascagni and others). (A.T.) ½

1, 1, upper inguinal glands receiving the lower abdominal, the inguinal, penile, and scrotal lymphatic vessels ; 2, 2, femoral or lower inguinal glands, receiving the anterior, internal, and external femoral lymphatic vessels ; 2′, the internal lymphatic vessels; 3, 3, large plexus of lymphatic vessels in the course of the internal saphenous vein ; 4, the same in the leg ; 5, posterior lymphatics of the calf of the leg ; 6, lymphatic vessels of the dorsum of the foot ; 7, those of the heel and inner ankle.

The **deep-seated inguinal glands,** less numerous than the superficial, surround the femoral artery and vein, and one is constantly placed in the crural ring. They receive the deep lymphatics of the limb and some of the efferent vessels of the superficial inguinal glands. The efferent vessels of the deep glands proceed upwards with the blood-vessels, the greater number passing through the crural ring, and terminate in the external iliac lymphatic glands.

The **superficial lymphatics of the lower limb** arise in two sets, one from the inner part of the dorsum and sole of the foot, the other from the outer. The *inner* vessels, the more numerous, follow a similar course to that of the internal saphenous vein : passing partly in front of and partly behind the inner ankle, they ascend along the inner side of the knee and front of the thigh, and terminate in the superficial inguinal glands. The *outer* vessels, ascending from the outer side of the foot, pass in great part obliquely across the popliteal space to join the inner set above the knee : in part they reach the inner set by crossing in front of the tibia ; and a small number of them, accompanying the external saphenous vein, dip down between the heads of the gastrocnemius muscle, and end in the popliteal glands. From the middle line

:he back of the thigh lymphatics pass round on both sides to reach inguinal glands. (Mascagni, "Vasorum Lymph. Historia," 1787.)

The **deep-seated lymphatics of the lower limb** are associated in ir whole course with the deep blood-vessels. In the leg they consist hree divisions, namely, anterior tibial, posterior tibial, and peroneal. ither these nor the superficial absorbents pass through any lymphatic ad in the leg, unless it be those lymphatics which accompany the erior tibial artery, near which a small gland is sometimes found he front of the interosseous membrane above the middle of the leg. several sets of deep lymphatics in the leg enter the lymphatic glands ated in the popliteal space. The efferent vessels from those glands joined by other lymphatics in contact with the branches of the femoral ry, and enter the deep inguinal glands. Other deep lymphatics ved from the muscles of the gluteal region, and many proceeding n the adductor muscles of the thigh, enter the cavity of the pelvis company with the gluteal, sciatic, and obturator arteries, and open a series of glands placed along the internal iliac vessels. The deep phatics of the buttock are sometimes interrupted by two or three ll glands, situated in the neighbourhood of the great sacro-tic foramen.

The **superficial lymphatics of the lower half of the trunk** con-ge to the superficial inguinal glands, the direction of some of them ng indicated by the superficial circumflex iliac and epigastric, and external pudic arteries. Externally they converge to the groin from gluteal region and from the lower part of the back, those from the er part crossing others which pass upwards to the axillary glands. eriorly they descend from the greater part of the surface of the omen, crossing and mingling above the umbilicus with vessels which end towards the axillary glands.

he **superficial lymphatics of the penis** usually form three vessels, being placed at the sides and the other on the dorsum of the an. Commencing in the prepuce, and beneath the skin of the glans the mucous lining of the urethra, they pass backwards, unite on the er surface of the penis, and, again subdividing, send branches on 1 side to the oblique inguinal glands. The *deep-seated lymphatics of penis* pass with the pudic vessels under the pubic arch, and end in glands on the internal iliac artery.

he **lymphatics of the scrotum** pass to the superficial inguinal ıds along the course of the external pudic arteries.

he lymphatics of the external generative organs in the female ent a disposition similar to that existing in the male.

### LYMPHATICS OF THE PELVIS AND ABDOMEN.

he **external iliac lymphatic glands,** from six to ten or more in ıber, clustering round the external iliac artery and vein, receive the rent vessels from the inguinal glands.

he **internal iliac lymphatic glands,** a numerous series placed ıg the internal iliac vessels, and the **sacral glands,** placed in the ow of the sacrum, receive the lymphatics from the pelvic viscera and etes.

he **lymphatics of the bladder,** few in number and confined to the hbourhood of the base of the organ (Curnow), enter the glands placed near the internal iliac artery; with these are associated the lymphatics of the prostate gland and vesiculæ seminales.

The **lymphatics of the uterus** in the unimpregnated state of the organ, are small, but during the period of gestation they are greatly enlarged. Issuing from the entire substance of the uterus, the greater number descend, together with those of the vagina, and pass backwards to enter the glands upon the internal iliac artery, thus following the course of the principal uterine blood-vessels. Others, proceeding from the upper end of the uterus, run outwards in the folds of peritoneum which constitute the broad ligaments, and, joining the lymphatics derived from the ovaries and Fallopian tubes, ascend with the ovarian vessels to the glands placed on the aorta and vena cava.

The **lymphatics of the rectum** are frequently of considerable size; immediately after leaving the intestine, some of them pass through small glands which lie contiguous to it, and finally, they enter the lymphatic glands situated in the hollow of the sacrum. At the anus, their capillary network is continuous with that of the cutaneous lymphatics.

The **lumbar lymphatic glands** are very numerous and are disposed in three groups, a mesial and two lateral. The glands of the *mesial* group are of large size, and surround the aorta and vena cava; they receive the efferent vessels of the external and internal iliac, and of the sacral glands, the lymphatics from the kidneys, suprarenal bodies and testicles (or ovaries with a part of the uterus), some of the efferent vessels of the lateral lumbar glands, and the lymphatics of the vertebral portion of the diaphragm. The glands of the *lateral* group are much smaller; they lie behind the psoas muscle, in the intervals between the transverse processes of the vertebræ, and receive the deep lymphatics of the hinder part of the abdominal wall. The greater number of the efferent vessels of the lumbar glands are generally united on each side into a short stem, the *lumbar lymphatic trunk*, which, with several smaller vessels, opens into the commencement of the thoracic duct.

The **lymphatics of the kidney** consist of a deep and a superficial set. Those placed upon the surface of the organ are comparatively small; they unite at the hilus of the kidney with the lymphatics from the interior of the gland, and then pass inwards to the mesial lumbar glands. The *lymphatics of the suprarenal capsules* unite with those of the kidney. The *lymphatic vessels of the ureter* are numerous; they communicate with those of the kidney and bladder, and for the most part terminate by union with the former.

The **lymphatics of the testicle** commence in the substance of the gland, and upon the surface of the tunica vaginalis. Collected into several large trunks, they ascend with the other constituents of the spermatic cord, pass through the inguinal canal, and accompany the spermatic vessels in the abdomen to enter some of the lumbar lymphatic glands.

The **deep lymphatics of the abdominal wall** in part pass along the circumflex iliac and epigastric arteries, to the external iliac glands; others accompany the ilio-lumbar and lumbar arteries, and, after being joined by lymphatics from the muscles of the back and the spinal canal, enter the lateral lumbar glands. The lymphatics from the upper part of the anterior wall ascend with the internal mammary vessels and enter the sternal glands in the thorax.

The **mesenteric glands** vary in number from a hundred and thirty

Fig. 306.

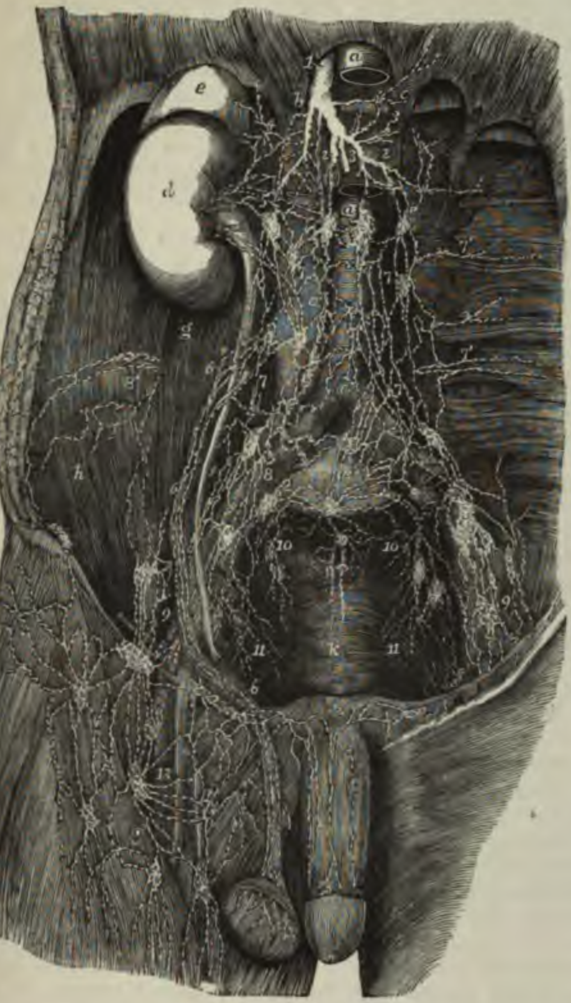


Fig. 306.—PRINCIPAL LYMPHATIC VESSELS AND GLANDS OF THE ABDOMEN AND PELVIS (modified from Mascagni). (A. T.) $\frac{1}{4}$

*a*, abdominal aorta, the upper part of it having been removed to show the formation of the thoracic duct; *a'*, inferior vena cava; *b*, right, *c*, left crus of the diaphragm; *d*, right kidney; *e*, suprarenal body; *f*, ureter; *g*, psoas muscle; *h*, iliacus; *k*, lower part of the sacrum; 1, commencement of the thoracic duct; 2, 2, lumbar lymphatic trunks; 3, intestinal lymphatic trunk; 4, suprarenal lymphatics; 5, renal; 6, 6, spermatic; 7, lumbar lymphatic vessels and glands; 7', 7', some of the lymphatics of the loins; 8, those surrounding the common iliac vessels, and proceeding from the lymphatics of the pelvis and lower limb; 8', some lymphatics of the abdominal wall; 8, to 9, external iliac glands; 10, 10, lateral sacral glands; above *k*, lymphatics of the rectum joining the mesial sacral glands; 11, internal iliac glands; 12, lymphatics of the dorsum of the penis passing to the glands of the groin; 13, deep inguinal glands.

large azygos vein. The duct runs upwards, gradually inclining to the left, and at the same time diminishing slightly in size, until it reaches

Fig. 304.

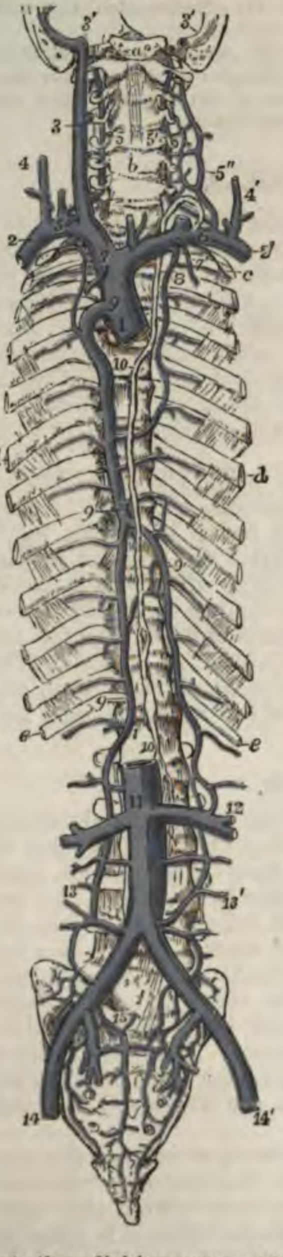


Fig. 304.—Sketch of the thoracic duct with the principal systemic veins. (A. T.) ¼

The full description of this figure will be found at p. 491.

10, 10, thoracic duct; the lower number is close to the receptaculum chyli; 6, on the left subclavian vein, marks the termination of the duct in the angle of union of the subclavian and internal jugular veins; 5, on the right subclavian vein, indicates the similar termination of the right lymphatic duct.

the fourth dorsal vertebra, where, passing behind the arch of the aorta, it becomes applied to the left side of the œsophagus lying between that tube and the left subclavian artery. Continuing its course into the neck to the level of the seventh cervical vertebra, it changes its direction and turns outwards, at the same time arching downwards and forwards so as to describe a curve over the apex of the pleura, and then terminates on the outer side of the internal jugular vein, in the angle formed by the union of that vein with the subclavian. The diminution in the size of the duct as it ascends is such that at the fifth dorsal vertebra it is often only two lines in diameter, but above this point it again enlarges. The duct is generally waving and tortuous in its course, and is often alternately contracted and enlarged at irregular intervals.

The thoracic duct has numerous double valves at short intervals throughout its whole course, the constrictions of their attachments giving a nodulated appearance to the vessel. They are more numerous in the upper part of the duct. At the termination of the duct in the veins there is a valve of two segments, so placed as to allow the contents of the duct freely to pass into the veins, but effectually preventing the reflux of either chyle or blood into the duct.

**Varieties.**—The thoracic duct is not always a single trunk throughout its whole extent; it is frequently divided for some distance into two vessels which afterwards unite, especially in the lower part of its course (normal according to Teichmann); sometimes it separates into three divisions, or even presents a plexiform arrangement, for a short distance

In very rare cases the duct is double throughout, the two canals opening into the right and left innominate veins (W. Krause); or it is represented by two vessels which are placed one on each side of the aorta, and unite at the root of the neck into a single trunk (Nuhn, W. Turner). Cruikshank, in one case, found the duct "triple or nearly so." In the neck, the thoracic duct often divides into two or three branches, which in some instances terminate separately in the great veins, but in other cases unite first into a common trunk; less frequently one of the branches passes across to the veins of the right side of the neck. In the lower animals the termination of the thoracic duct in the veins of the right side as well as of the left is not uncommon. As a rare occurrence the trunk has been found passing upwards through the posterior mediastinum on the left side of the aorta (Henle, G. D. T.). Several cases are recorded in which, the viscera not being transposed, the thoracic duct terminated in the veins of the right side, with a right aortic arch (Allen Thomson), with a root-origin of the right subclavian artery (Fleischmann, Todd, J. M. Brown), or with a normal arrangement of the great arteries (Morrison Watson). In two instances the thoracic duct has been observed entering the large azygos vein (Wutzer, Arnold). (See Vol. II., p. 207.)

### RIGHT LYMPHATIC DUCT.

The right lymphatic duct is a short vessel, about a line or a little more in diameter, and from a quarter to half an inch in length, which receives the lymph from the absorbents of the right upper limb, the right side of the head and neck, the right side of the chest, the right lung and the right half of the heart, and from part of the upper surface of the liver. It enters obliquely into the receding angle formed by the union of the right subclavian and internal jugular veins, where its orifice is guarded by a double valve. The vessels which usually unite to form this trunk, however, frequently terminate independently in the large veins.

### LYMPHATICS OF THE LOWER LIMB.

The lymphatics of the lower limb are arranged in a superficial and a deep series. Those of the superficial series, together with the superficial lymphatics of the lower half of the trunk, converge to the superficial inguinal glands, with the exception of a few which dip into the popliteal space. Those of the deep series enter the deep inguinal glands.

The **popliteal lymphatic glands,** usually very small, and four or five in number, surround the popliteal vessels, and are imbedded in a quantity of loose fat. They receive from below the deep lymphatics of the leg, and a few superficial ones which accompany the short saphenous vein; their efferent vessels ascend with the femoral vein to the groin.

The **superficial inguinal glands** vary much in number, amounting on an average to eight or ten: they are divisible into a superior or oblique and an inferior or vertical set. The oblique glands lie in the line of Poupart's ligament and receive lymphatics from the integument of the trunk, gluteal region, perineum, and genital organs; the vertical glands surround the upper end of the long saphenous vein, and extend two or three inches downwards along the course of that vessel; they receive the superficial lymphatics of the limb. The efferent vessels of the superficial inguinal glands perforate the fascia, a large number passing through the saphenous opening, and some enter the deep inguinal glands, while others are continued upwards with the deep vessels into the abdomen, and join the lymphatic glands which lie along the external iliac artery.

Fig. 305.

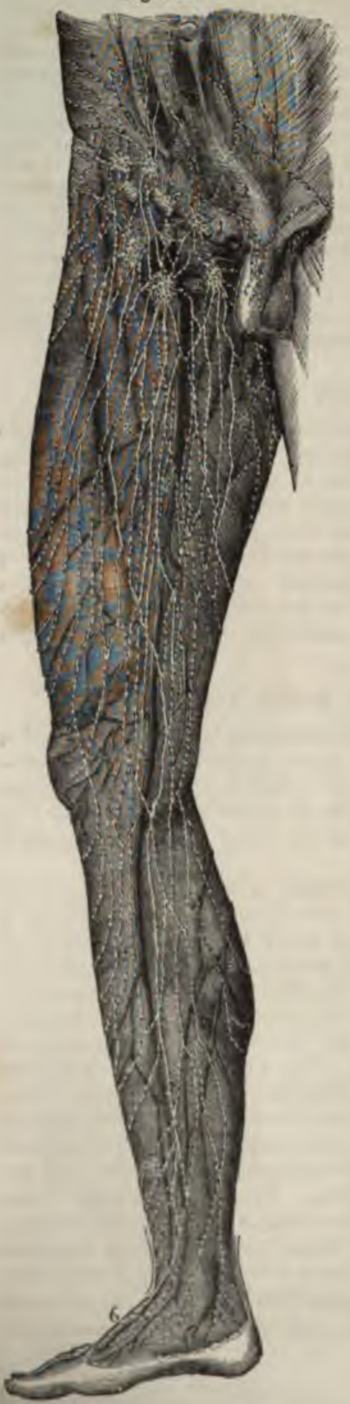


Fig. 305.—The superficial lymphatic vessels and glands of the lower limb, from the front and inner side (founded on Mascagni and others). (A. T.) ⅙

1, 1, upper inguinal glands receiving the lower abdominal, the inguinal, penile, and scrotal lymphatic vessels; 2, 2, femoral or lower inguinal glands, receiving the anterior, internal, and external femoral lymphatic vessels; 2′, the internal lymphatic vessels; 3, 3, large plexus of lymphatic vessels in the course of the internal saphenous vein; 4, the same in the leg; 5, posterior lymphatics of the calf of the leg; 6, lymphatic vessels of the dorsum of the foot; 7, those of the heel and inner ankle.

The **deep-seated inguinal glands**, less numerous than the superficial, surround the femoral artery and vein, and one is constantly placed in the crural ring. They receive the deep lymphatics of the limb and some of the efferent vessels of the superficial inguinal glands. The efferent vessels of the deep glands proceed upwards with the blood-vessels, the greater number passing through the crural ring, and terminate in the external iliac lymphatic glands.

The **superficial lymphatics of the lower limb** arise in two sets, one from the inner part of the dorsum and sole of the foot, the other from the outer. The *inner* vessels, the more numerous, follow a similar course to that of the internal saphenous vein: passing partly in front of and partly behind the inner ankle, they ascend along the inner side of the knee and front of the thigh, and terminate in the superficial inguinal glands. The *outer* vessels, ascending from the outer side of the foot, pass in great part obliquely across the popliteal space to join the inner set above the knee; in part they reach the inner set by crossing in front of the tibia; and a small number of them, accompanying the external saphenous vein, dip down between the heads of the gastrocnemius muscle, and end in the popliteal glands. From the middle line of the back of the thigh lymphatics pass round on both sides to reach the inguinal glands. (Mascagni, "Vasorum Lymph. Historia," 1787.)

The **deep-seated lymphatics of the lower limb** are associated in their whole course with the deep blood-vessels. In the leg they consist of three divisions, namely, anterior tibial, posterior tibial, and peroneal. Neither these nor the superficial absorbents pass through any lymphatic gland in the leg, unless it be those lymphatics which accompany the anterior tibial artery, near which a small gland is sometimes found on the front of the interosseous membrane above the middle of the leg. The several sets of deep lymphatics in the leg enter the lymphatic glands situated in the popliteal space. The efferent vessels from those glands are joined by other lymphatics in contact with the branches of the femoral artery, and enter the deep inguinal glands. Other deep lymphatics derived from the muscles of the gluteal region, and many proceeding from the adductor muscles of the thigh, enter the cavity of the pelvis in company with the gluteal, sciatic, and obturator arteries, and open into a series of glands placed along the internal iliac vessels. The deep lymphatics of the buttock are sometimes interrupted by two or three small glands, situated in the neighbourhood of the great sacro-sciatic foramen.

The **superficial lymphatics of the lower half of the trunk** converge to the superficial inguinal glands, the direction of some of them being indicated by the superficial circumflex iliac and epigastric, and the external pudic arteries. Externally they converge to the groin from the gluteal region and from the lower part of the back, those from the latter part crossing others which pass upwards to the axillary glands. Anteriorly they descend from the greater part of the surface of the abdomen, crossing and mingling above the umbilicus with vessels which ascend towards the axillary glands.

The **superficial lymphatics of the penis** usually form three vessels, two being placed at the sides and the other on the dorsum of the organ. Commencing in the prepuce, and beneath the skin of the glans and the mucous lining of the urethra, they pass backwards, unite on the upper surface of the penis, and, again subdividing, send branches on each side to the oblique inguinal glands. The *deep-seated lymphatics of the penis* pass with the pudic vessels under the pubic arch, and end in the glands on the internal iliac artery.

The **lymphatics of the scrotum** pass to the superficial inguinal glands along the course of the external pudic arteries.

The lymphatics of the external generative organs in the female present a disposition similar to that existing in the male.

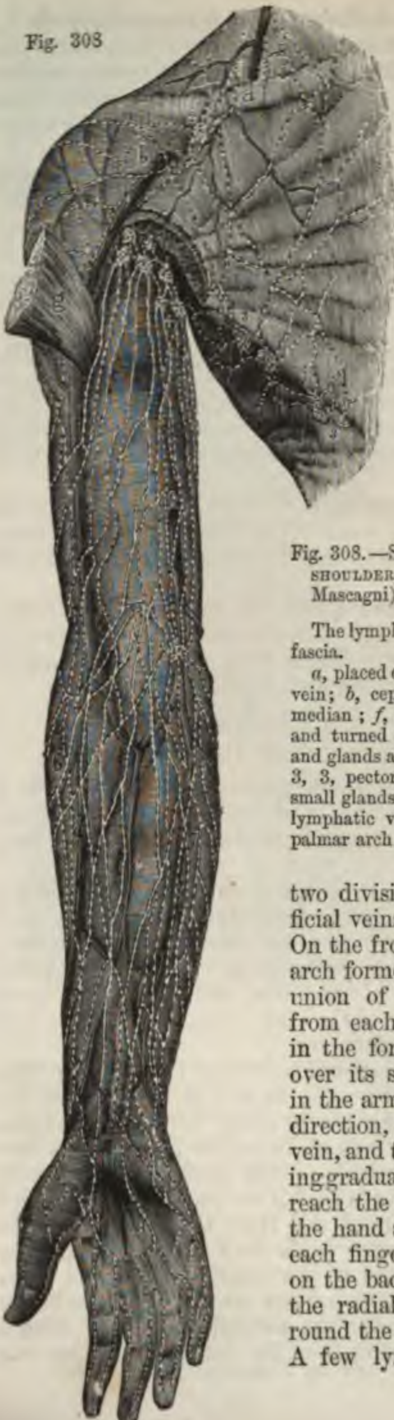
## LYMPHATICS OF THE PELVIS AND ABDOMEN.

The **external iliac lymphatic glands,** from six to ten or more in number, clustering round the external iliac artery and vein, receive the efferent vessels from the inguinal glands.

The **internal iliac lymphatic glands**, a numerous series placed along the internal iliac vessels, and the **sacral glands**, placed in the hollow of the sacrum, receive the lymphatics from the pelvic viscera and parietes.

The **lymphatics of the bladder**, few in number and confined to the neighbourhood of the base of the organ (Curnow), enter the glands

Fig. 308



and the shoulder, and are connected above with the inferior cervical glands, below with the axillary glands.

The efferent vessels of the axillary glands ascend with the subclavian vein, and form by their union in some cases a single trunk (*axillary lymphatic trunk*), in others two or three large vessels, which terminate on the left side in the thoracic duct, on the right side in the right lymphatic duct. Sometimes they open separately into the subclavian vein near its termination.

Fig. 308.—SUPERFICIAL LYMPHATICS OF THE BREAST, SHOULDER, AND UPPER LIMB, FROM BEFORE (after Mascagni). (A. T.) ⅓

The lymphatics are represented as lying upon the deep fascia.

*a*, placed on the clavicle, points to the external jugular vein; *b*, cephalic vein; *c*, basilic vein; *d*, radial; *e*, median; *f*, ulnar vein; *g*, great pectoral muscle, cut and turned outwards; 1, superficial lymphatic vessels and glands above the clavicle; 2, infraclavicular glands; 3, 3, pectoral glands; 4, 4, axillary glands; 5, two small glands placed near the bend of the arm; 6, radial lymphatic vessels; 7, ulnar lymphatic vessels; 8, 8, palmar arch of lymphatics

The **superficial lymphatics of the upper limb** are usually described as forming two divisions corresponding with the superficial veins on the outer and inner borders. On the front of the limb they arise from an arch formed in the palm of the hand by the union of two lymphatic vessels proceeding from each finger. becoming more numerous in the forearm, they are found thickly set over its surface, whence they pass upwards in the arm; the inner vessels in a straight direction, following the course of the basilic vein, and those placed further outwards inclining gradually inwards over the biceps muscle to reach the axillary glands. On the back of the hand also, two lymphatics proceed from each finger; and from the copious network on the back of the forearm vessels pass over the radial margin, and in greater number round the ulnar side to join those in front. A few lymphatic vessels ascend with the cephalic vein to the glands in the infraclavicular fossa, and these are joined by others which pass forwards from the shoulder.

The **deep lymphatics of the upper limb** correspond with the deep blood-vessels. In the forearm they consist, therefore, of three sets, associated respectively with the radial, ulnar, and interosseous arteries and veins. In their progress upwards, they communicate near the wrist with the superficial lymphatics, and some of them enter the glands which lie by the side of the brachial artery near the bend of the elbow. They all terminate in the glands of the axilla.

The **superficial lymphatics of the chest** include the vessels running under cover of, and collecting lymph from, the pectoral muscles, the cutaneous lymphatics of this region, and the greater number of the lymphatics of the mamma. They are directed outwards and traverse the pectoral glands on their way to join the principal axillary glands. Associated with these vessels are the superficial lymphatics of the upper part of the abdominal wall, which commence about the level of the umbilicus, where they decussate with others passing downwards to the superficial inguinal glands, and then ascend to the pectoral and axillary glands.

The **superficial lymphatics of the back** converge to the axillary glands from its various regions; from the neck over the surface of the trapezius muscle, from the posterior part of the deltoid, and from the whole dorsal and lumbar regions as low as the crest of the ilium; the branches decussating inferiorly with vessels leading to the inguinal glands, and likewise crossing the middle line so as to decussate with branches of the opposite side. (Mascagni, tab. xxii., xxiii., xxiv.)

## LYMPHATICS OF THE HEAD AND NECK.

The lymphatic glands of the head are comparatively few and small; those of the neck are, on the contrary, large and numerous. The following groups of glands, with their associated vessels, are distinguished:—

**1.** One or two **suboccipital glands** are placed beneath the skin, over the upper end of the complexus muscle, and receive the lymphatics from the hindmost part of the scalp; their efferent vessels join the superficial cervical glands.

**2.** The **mastoid glands** are two or three in number, and lie over the insertion of the sterno-mastoid muscle; they receive lymphatics which descend from the scalp behind the ear, and their efferent vessels enter the superficial cervical glands.

**3.** The **parotid lymphatic glands,** three or four of small size, lie beneath the parotid fascia, and are frequently more or less embedded in the substance of the parotid gland; one, larger than the others, is situated immediately in front of the tragus of the ear. They receive the superficial lymphatics descending from the temporal region, and their efferent vessels pass to the submaxillary and superficial cervical glands.

**4.** The **internal maxillary glands** are placed deeply beneath the ramus of the lower jaw, one or two with the internal maxillary artery, others on the hinder part of the buccinator muscle and the side wall of the pharynx. Their afferent vessels are derived from the temporal, zygomatic, orbital and nasal fossæ, as well as the palate and upper part of the pharynx; their efferent vessels enter the superior deep cervical glands.

**5.** The **submaxillary lymphatic glands,** from eight to ten or m
in number, lie beneath the base of the inferior maxilla, and receive
superficial lymphatics of the face, the lymphatics of the floor of the mo
and of the submaxillary and sublingual salivary glands, as well as mo

Fig. 309.

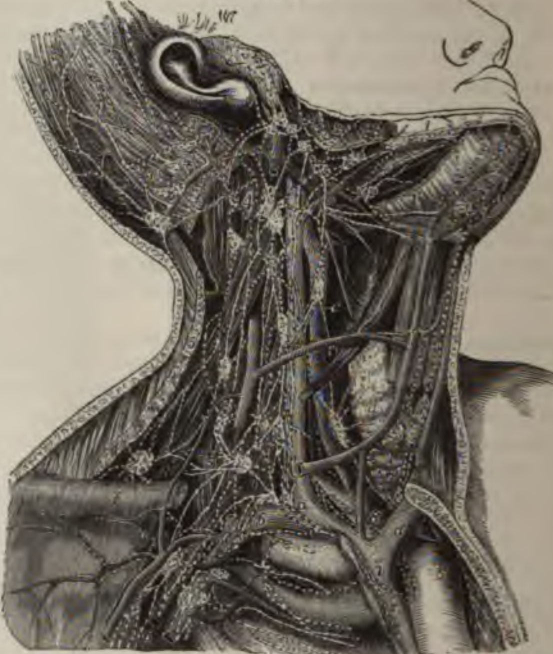


Fig. 309.—PRINCIPAL LYMPHATIC VESSELS AND GLANDS OF THE HEAD AND NECK
RIGHT SIDE (after Bourgery in part). (A. T.) ⅓

The inner half of the clavicle and part of the sternum have been removed so as to
the arch of the aorta, and the innominate artery and veins; the posterior belly
omo-hyoid muscle is removed; and the sterno-mastoid, sterno-hyoid, and sterno-
muscles, and the external jugular vein have been divided so as to expose the deep

*a*, right innominate vein at the place where it is joined by the principal lymphatic
*a′*, the left vein; *b*, arch of the aorta; *c*, common carotid artery; *d*, thyroid body
by the anterior jugular vein; *e*, cut surface of the sternum; *f*, outer part of the c
1, submaxillary lymphatic glands; 1′, lingual; 2, parotid; 3, occipital and mast
superior deep cervical; 5, 5, inferior deep cervical glands; 6, 6, axillary glands; 7
superior vena cava, some of the anterior mediastinal vessels; 8, on the inn
artery, some of the superior mediastinal; to these last are seen descending som
lymphatics from the thyroid body and lower part of the neck.

the vessels emerging from the parotid lymphatic glands. Their e
vessels pass to both superficial and deep cervical glands. There a
quently also one or two small glands (*suprahyoid*—Sappey) placed
centre of the neck between the anterior bellies of the two digastric m
and connected with the lymphatics descending from the lower lip.

**6.** The **superficial cervical glands,** from four to six, lie alon
external jugular vein, between the platysma myoides and the deep
They are joined by the lymphatics of the external ear, and c

integument of the neck, by the vessels issuing from the suboccipital and mastoid glands, and by some of those from the parotid and submaxillary lymphatic glands. Their efferent ducts enter the inferior deep cervical glands. One or two small glands are sometimes found near the middle line of the front of the neck between the hyoid bone and the sternum, less frequently at the back of the neck over the trapezius muscle.

7. The **deep cervical glands** are very numerous (twenty to thirty), and are subdivided into superior and inferior. The *superior* extend from the bifurcation of the common carotid artery to the base of the skull, lying for the most part along the internal jugular vein. They receive the efferent vessels of the internal maxillary and some of the submaxillary glands, the lymphatics of the cranial cavity, the tongue, larynx, and lower part of the pharynx, some of those of the thyroid body and the deep muscles of the neck. Their efferent vessels descend to the following glands. The *inferior deep cervical glands* are grouped around the lower part of the internal jugular vein, and extend outwards into the supraclavicular fossa, becoming continuous below with the glands of the superior mediastinum internally, and those of the axilla externally. They receive the efferent vessels of the other cervical glands, both superficial and deep, and the lymphatics from the lower part of the neck. Their efferent ducts unite to form a single vessel (*jugular lymphatic trunk*) which terminates in the thoracic (or right lymphatic) duct, or sometimes separately in one of the large veins.

The **lymphatics of the scalp** descend partly over the occiput and behind the ear to the suboccipital and mastoid glands, and partly in front of the ear to the parotid lymphatic glands. From the forehead other vessels pass downwards and join the lymphatics of the face.

The **superficial lymphatics of the face** are directed for the most part obliquely downwards in the course of the facial vein, and enter the submaxillary glands, but those springing from the outer parts of the eyelids and cheek pass backwards to the parotid glands. The *deep lymphatics of the face*, including those of the orbit, nasal cavity, roof of the mouth, and interior of the cheek, terminate in the internal maxillary glands.

The **lymphatics of the cranial cavity** take their origin in networks contained in the pia mater on the surface of the brain and in the choroid plexuses of the ventricles. At the base of the brain they are collected into larger vessels which descend along the internal carotid and vertebral arteries and the internal jugular vein to the deep cervical glands. The lymphatics springing from the choroid plexuses of the lateral and third ventricles run backwards and unite into a considerable trunk which accompanies the veins of Galen between the layers of the velum interpositum.

The **lymphatics of the tongue** are mainly directed backwards in company with the ranine vein, and traverse two or three small *lingual glands*, lying on the outer surface of the hyo-glossus muscle, on their way to join the superior deep cervical glands. From the fore part of the tongue, also, one or two vessels pass downwards together with the lymphatics of the floor of the mouth and, after perforating the mylo-hyoid muscle, enter the submaxillary glands.

# NEUROLOGY.

THE nervous system consists of central and peripheral
first belong those large masses of nervous substance for
and spinal cord, or great cerebro-spinal centre ; and to th
the various nervous cords, cerebro-spinal and sympath
distributed in different parts of the body. Along
nervous system also includes the organs of the externa
ganglia.

The description of the cerebro-spinal centre and of th
senses will be given in the Second Volume. The present
the descriptive anatomy of the cerebro-spinal and sym
and of the ganglia connected with them.

## THE CEREBRO-SPINAL NERVES

The nerves springing directly from the great cereb
constitute a series of symmetrical pairs, of which a certai
from the cranium through different apertures in its base,
named *cranial*. The next following nerve passes ou
occipital bone and the atlas, and the remaining thirty
below the corresponding segments of the vertebral colum
sometimes distinguished by the name of *suboccipital*, b
series of thirty-one nerves the name of *spinal* will be her

### CRANIAL NERVES.

The cranial nerves, besides being distinguished by
order of their passage through the dura mater lining th
likewise received other names, according to the place o
distribution, or their functions.

The number of the cranial nerves has been variously

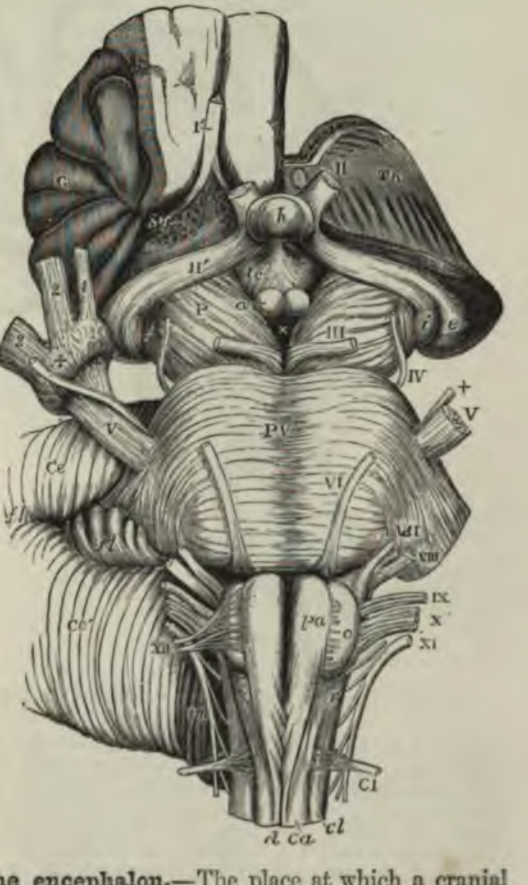
| WILLIS. | SŒMMERRING. | OTHER NAMES. |
|---|---|---|
| First pair of nerves . | First pair of nerves . | Olfactory nerves. |
| Second " | Second " | Optic. |
| Third " | Third " | Common oculomotor. |
| Fourth " | Fourth " | Pathetic or trochlear. |
| Fifth " | Fifth " | Trifacial or trigeminal. |
| Sixth " | Sixth " | Abducent ocular. |
| Seventh " { portio dura . | Seventh " | Facial motor. |
| Seventh " { portio mollis | Eighth " | Auditory. |
| Eighth " { n. vagus | { Ninth " | Glosso-pharyngeal. |
| | { Tenth " | Pneumo-gastric. |
| Eighth " { n. accessorius | Eleventh " | Spinal accessory. |
| Ninth " " | Twelfth " | Hypoglossal or lingual motor. |

The arrangement of Sœmmerring is on the whole the preferable one, and is therefore followed throughout this work, in accordance with the more general custom among anatomical writers of the present day.

Fig. 310.—VIEW FROM BELOW OF THE CONNECTION OF THE PRINCIPAL CRANIAL NERVES WITH THE BRAIN. (A. T.)

The full description of this figure will be found at p. 283 of Vol. II. The following references apply to the roots of the nerves: I′, right olfactory tract, divided near its middle; II, left optic nerve, springing from the commissure which is concealed by the pituitary body; II′, right optic tract; the left tract is seen passing back into *i* and *e*, the internal and external corpora geniculata; III, left oculomotor nerve; IV, trochlear; V, V, large roots of the trifacial nerves; + +, small roots, the + of the right side is placed on the Gasserian ganglion; 1, ophthalmic, 2, superior maxillary, and 3, inferior maxillary nerves; VI, left abducent nerve; VII, facial; VIII, auditory; IX, glosso-pharyngeal; X, pneumogastric; XI, spinal accessory; XII, right hypoglossal nerve; at *o*, on the left side, the rootlets are seen cut short; C I, sub-occipital or first cervical nerve.

Fig. 310.



**Connection with the encephalon.**—The place at which a cranial nerve is attached to the surface of the brain is termed the *superficial origin* of the nerve. From this apparent origin, however, the nerve-roots can be traced for a variable depth within the substance of the encephalon to certain collections of nerve-cells or *nuclei*, the connection with which constitutes the *deep origin* of the nerve. The superficial origins of these nerves are quite obvious: the filaments of the first pair spring from the olfactory lobes of the cerebral hemispheres; the second pair arise from the dorsal part of the mesencephalon; the third are attached to the crura cerebri or ventral part of the mesencephalon; the fourth to the valve of Vieussens; the fifth to the pons; and the remainder to the medulla oblongata, with the exception of the greater part of the eleventh pair, which arise from the cervical portion of the spinal cord. The course of the fibres within the cerebro-spinal centre, and their connection with the nerve-nuclei are described in the Second

Fig. 311.

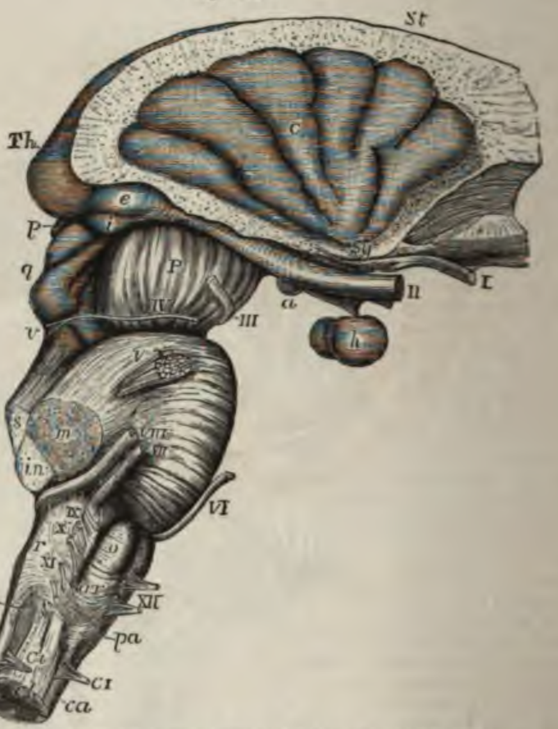


Fig. 311.—Lateral view of the connection of the cranial nerves with the brain. (A. T.)

The full description of this figure will be found at p. 285, Vol. II. The following references apply to the roots of the nerves: I, right olfactory tract, cut near its middle; II, the optic nerves immediately in front of the commissure; the right optic tract is seen passing back to the thalamus (*Th*), corpora geniculata (*i*, *e*), and corpora quadrigemina (*q*); III, oculomotor nerve; IV, trochlear nerve rising at *v*, from the valve of Vieussens; V, trifacial nerve; VI, abducent ocular; VII, VIII, facial and auditory nerves; between them the pars intermedia; IX, glosso-pharyngeal; X, pneumo-gastric; XI, spinal accessory; XII, hypoglossal; C I, the separate anterior and posterior roots of the suboccipital or first cervical nerve.

olume (pp. 363-370), and will not be farther referred to in this place, here the descriptions of the several nerves will commence with their ppearance on the surface of the brain.

**Mode of exit from the cranium.**—Each of the cranial nerves in aving the cranial cavity passes through a foramen or tubular prolongaion of the dura mater : some of these nerves or their main divisions are ontained in distinct foramina of the cranium, others are grouped

Fig. 312.

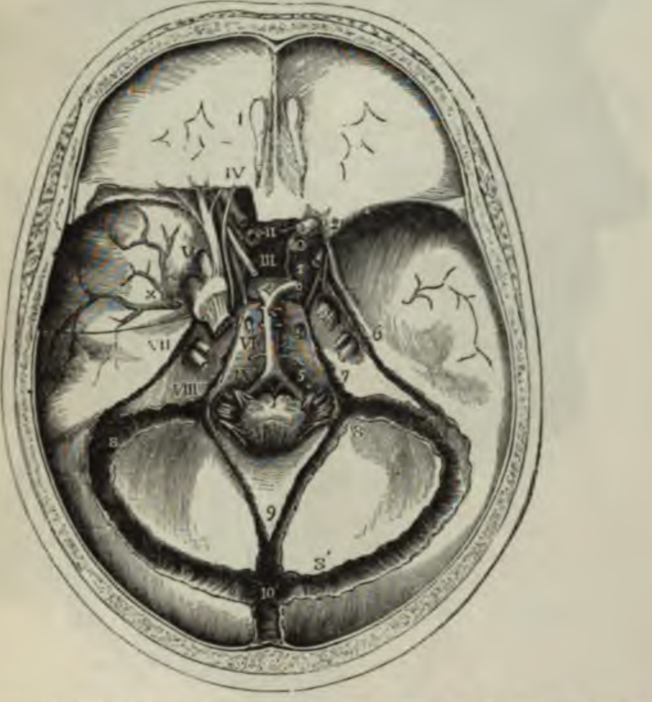
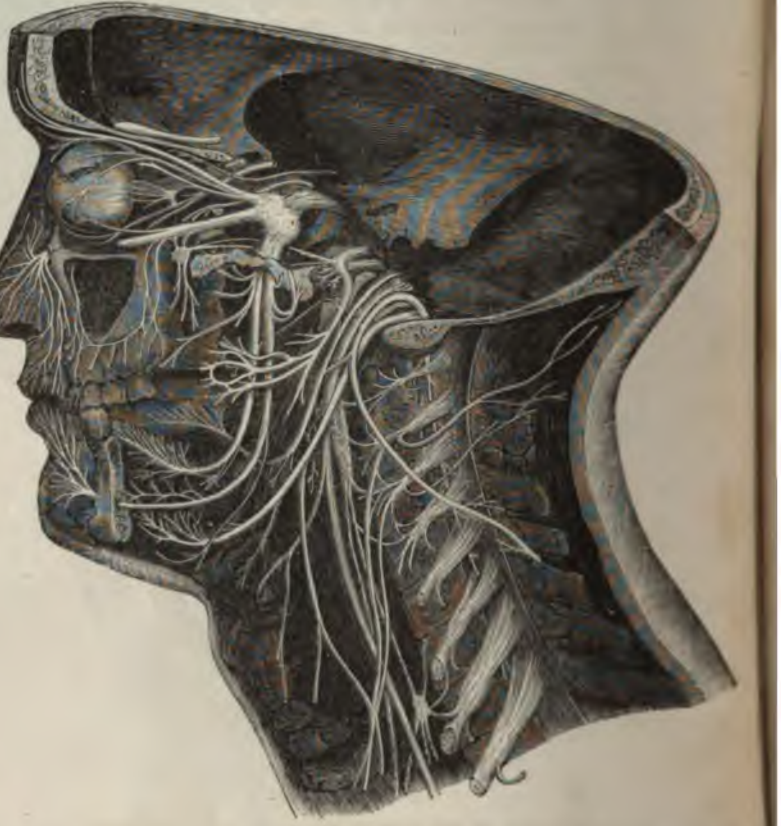


Fig. 312.—Internal view of the base of the skull, showing the places of exit of the cranial nerves. (A. T.) ½

The dura mater is left for the most part within the base of the skull ; the tentorium is removed and the venous sinuses are opened. On the left side a small portion of the roof of the orbit has been removed to show the relation of certain nerves at the cavernous sinus and in the sphenoidal fissure. The roots of the several cranial nerves have been divided a short distance internal to the foramina of the dura mater through which they respectively pass. I, olfactory bulb, lying over the cribriform plate of the ethmoid bone ; II, optic nerves ; III, common oculomotor nerve ; IV, trochlear nerve ; V, is placed on the left side opposite to the middle of the three divisions of the trifacial nerve, which, together with the ganglion and large root, have been exposed by opening up the dura mater ; on the right side the large root only is seen ; VI, abducent ocular nerve ; VII, placed on the upper part of the petrous bone opposite the entrance of the facial and auditory nerves into the internal auditory meatus ; VIII, placed on the petrous bone outside the jugular foramen opposite the place of exit of the glosso-pharyngeal, pneumo-gastric and spinal accessory nerves ; IX, hypoglossal nerve. On the left side, in relation with the cavernous sinus, the third, fourth, and ophthalmic division of the fifth nerves are seen keeping towards the outer side, while the sixth nerve is deeper and close to the internal carotid artery. The explanation of the remaining references in this figure will be found at p. 504.

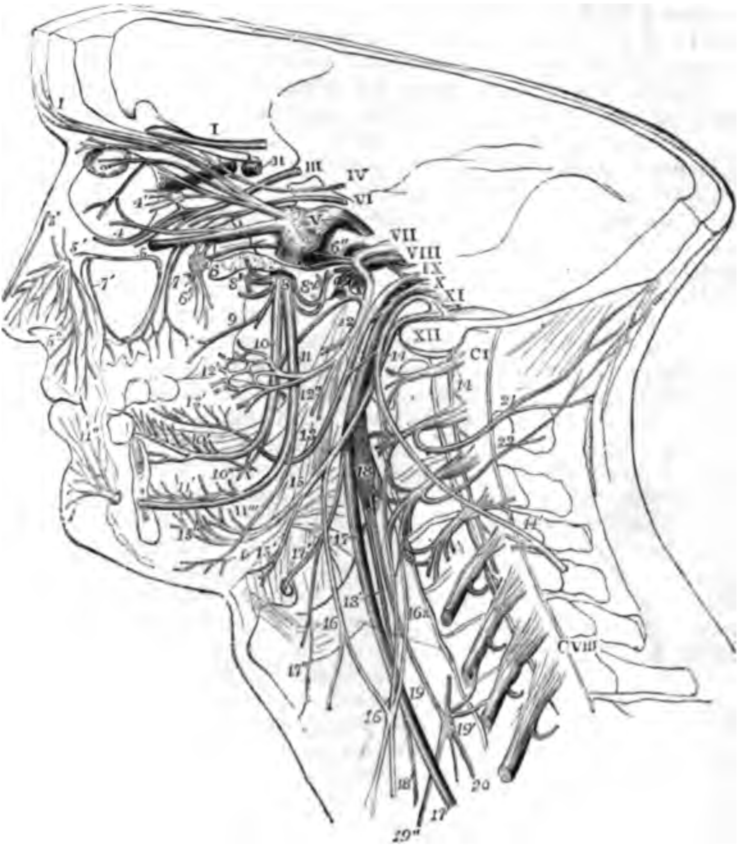
Fig. 313.—A. SEMIDIAGRAMMATIC VIEW OF A DEEP DISSECTION OF THE CRANIAL NERVES ON THE LEFT SIDE OF THE HEAD (from various authors and from nature). B. EXPLANATORY OUTLINE OF THE SAME. (A.T.) ½

Fig. 313, A.



The Roman numerals from I to XII indicate the roots of the several cranial nerves as they lie in or near their foramina of exit ; V, is upon the large root of the fifth with the Gasserian ganglion in front ; C I, the suboccipital or first cervical nerve ; C VIII, the eighth. The branches of the nerves are marked as follows, viz. :—1, supraorbital branch of the fifth ; 2, lachrymal passing into the gland ; 3, nasal passing towards the anterior internal orbital canal, and giving the long root to the ciliary ganglion, 4′ ; 3′, termination of the nasal nerve ; 4, lower branch of the third nerve ; 5, superior maxillary division of the fifth passing into the infraorbital canal ; 5′, the same issuing at the infraorbital foramen and being distributed as inferior palpebral, lateral nasal, and superior labial nerves, 5″ ; 6, ganglion of Meckel and Vidian nerve passing back from it ; 6′, palatine and other nerves descending from it ; 6″, large superficial petrosal nerve ; 7, posterior dental nerves ; 7′, placed in the antrum, which has been opened, points to the anterior dental nerve ; 8, inferior maxillary division of the fifth immediately below the foramen ovale ; 8′, some of the muscular branches coming from it ; 8+, the auriculo-temporal branch cut short, and above it the small superficial petrosal nerve connected with the facial ; 9, buccal and external pterygoid ; 10, lingual or gustatory nerve ; 10′, its distribution to the side and front of the tongue and to the sublingual gland ; 10″, submaxillary ganglion ; below 10, the chorda tympani passing forwards from the facial above 12, to join the lingual nerve ; 11, inferior dental nerve ; 11′, the same nerve and part of its dental distribution exposed by removal of the jaw ; 11″, its termination as the mental nerve ; 11‴, its mylo-hyoid branch ; 12, twigs of the facial nerve immediately after its exit from the stylo-mastoid foramen to the posterior belly of the digastric and to the stylo-hyoid muscle ; 12′, temporo-facial division of the facial ; 12″, cervico-facial division ; 13, trunk of the glosso-pharyngeal passing round the stylo-pharyngeus muscle after giving pharyngeal and muscular branches ; 13′, its distribution on the side and back part of the tongue ; 14, spinal accessory nerve ; 14′, the same after having passed through the sterno-mastoid muscle uniting with branches from the cervical nerves ; 15, hypoglossal nerve ; 15′, its twig to the thyro-hyoid muscle ; 15″, its distribution to the muscles of the tongue ; 16, its descending branch giving a direct offset to the anterior belly of the omo-hyoid muscle, and receiving the communicating branches 16 +, from the cervical nerves ; 17, pneumo-gastric nerve ; 17′, its superior laryngeal branch ; 17″, external laryngeal twig ; 18, superior cervical ganglion of the sympathetic nerve, uniting with the upper cervical nerves, and giving at 18′ the superficial cardiac nerve ; 19, the trunk of the sympathetic ; 19′, the middle cervical ganglion, uniting with some of the cervical nerves, and giving 19″, the large or middle cardiac nerve ; 20, continuation of the sympathetic nerve down the neck ; 21, great occipital nerve ; 22, third occipital.

Fig. 313, B.



together in one foramen. The numerous small olfactory nerves descend into the nose through the cribriform plate of the ethmoid bone; the optic nerve pierces the root of the small wing of the sphenoid bone; the third, fourth, and sixth nerves, with the ophthalmic division of the fifth, pass through the sphenoidal fissure; the superior maxillary and inferior maxillary divisions of the fifth pass respectively through the foramen rotundum and foramen ovale of the great wing of the sphenoid; the facial and auditory nerves pierce the petrous bone; the glosso-pharyngeal, pneumo-gastric, and spinal accessory nerves descend through the middle compartment of the jugular foramen between the petrous and occipital bones; and the hypoglossal nerve passes through the anterior condylar foramen of the occipital bone.

**General distribution.**—The greater number of the cranial nerves are entirely confined in their distribution within the limits of the head, as in the case of the first six pairs, the auditory and glosso-pharyngeal nerves. Of these, the olfactory, optic, and auditory are restricted to their respective organs of sense; while the third, fourth, and sixth are exclusively motor nerves in connection with the muscles of the eyeball and the elevator of the upper eyelid. In the fifth or trifacial nerve all the fibres derived from the large root, and connected with the Gasserian ganglion, are entirely sensory in their function, and constitute the whole of the first and second and the greater part of the third division of the nerve; but the last of these divisions has associated with it the fibres of the small or motor root, so as to become in some degree a compound nerve. As a nerve of sensation the trifacial occupies in its distribution the greater part of the head superficially and deeply, excepting the interior of the cranium and that part of the scalp which is situated behind a perpendicular line passing through the external auditory meatus. The muscular distribution of the inferior division of the fifth nerve is chiefly to the muscles of mastication. The glosso-pharyngeal is also a mixed nerve, and is distributed to the tongue, pharynx, and part of the ear-passages.

Of the remaining nerves, the facial and hypoglossal, both exclusively motor in function, are almost entirely cephalic in their distribution; the facial nerve giving fibres to all the superficial and a few of the deeper muscles of the head and face; and the twelfth or hypoglossal supplying the muscles of the tongue. Of the facial, however, one branch passes downwards in the neck to the platysma myoides; and of the twelfth, the descending branch supplies in part the muscles of the neck which depress the hyoid bone and larynx.

Lastly, the tenth or pneumo-gastric and the eleventh or spinal accessory nerves differ from the foregoing in having only a very limited distribution in the head and in furnishing nerves in much greater proportion to organs situated in the neck and trunk. The first of these, after giving a small branch to the external ear, and supplying nerves to the pharynx and larynx, the trachea, gullet, lungs and heart, extends into the abdominal cavity as the principal nerve of the stomach. The other, the spinal accessory, which is classed with the cranial nerves in consequence of its passing out through one of the foramina of the skull, is entirely a motor nerve; it is partially united with the pneumo-gastric near its origin, and thus furnishes some of the motor fibres of that nerve, but it is mainly distributed to the sterno-mastoid and trapezius muscles.

On pages 546 and 547, fig. 313 is introduced in illustration of the general view of the distribution above given. In this figure the cranium and orbit have been opened up to the depth of the several foramina through which the nerves pass. The great part of the lower jaw has also been removed on the left side, and the tongue, pharynx, and larynx are partially in view. The occipital bone has been divided by an incision passing down from the occipital protuberance and through the condyle to the left of the foramen magnum. The cervical vertebræ have been divided to the left of the middle, and the sheath of the spinal cord opened so as to expose the roots of the cervical nerves.

## I.—OLFACTORY NERVES.

The olfactory nerves are slender filaments, about twenty in number, which spring from the under surface of the olfactory bulb, and descend to the nose through the foramina in the cribriform plate of the ethmoid bone, each being invested by tubular prolongations of the membranes of the brain. They form an inner group, which are lodged for some distance in groves on the surface of the vertical plate of the ethmoid, and then break up into tufts of branches before being distributed to the mucous membrane over that bone, and an outer group which ramify over the mesial surface of the lateral mass of the ethmoid, including the upper and middle turbinate bones. None of the branches reach the lower turbinate bone. The olfactory nerves are composed exclusively of non-medullated fibres, and their branches communicate freely with each other as they descend, thus giving rise to a narrow meshed plexus beneath the mucous membrane, especially on the outer wall of the fossa. (See also the anatomy of the nose in Vol. II.)

Fig. 314.

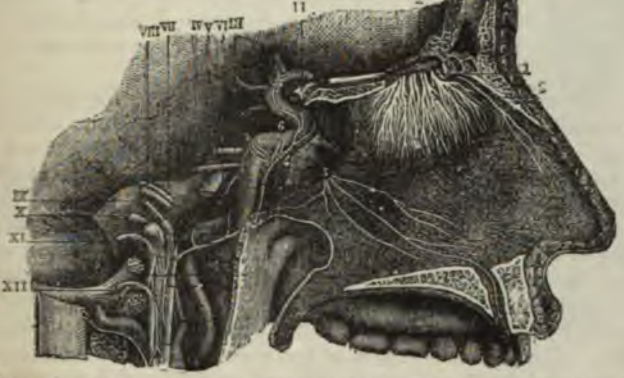


Fig. 314.—Distribution of the olfactory nerves on the septum of the nose (from Sappey, after Hirschfeld and Leveillé). $\frac{2}{3}$

The septum is exposed and the anterior palatine canal opened on the right side. I, points to the olfactory bulb, and the remaining Roman numbers to the several cranial nerves; 1, the olfactory nerves as they pass through the cribriform plate; 2, internal twig of the nasal branch of the ophthalmic nerve; 3, naso-palatine nerve. (See fig. 321, p. 563, for a view of the distribution of the olfactory nerves on the outer wall of the nasal fossa.)

The olfactory lobe of the cerebral hemisphere is sometimes described as the olfactory nerve (see Vol. II., pp. 331 and 334).

the third, the longest of the three, runs onwards between the lower and the outer rectus, and terminates below the ball of the eye in the inferior oblique muscle. The last-mentioned branch is connected with the lower part of the lenticular ganglion by a short thick offset (*short root of the ganglion*), and gives one or two filaments to the lower rectus muscle.

The several branches of the third nerve enter the muscles to which they are distributed on the surface which in each is turned towards the eyeball, with the exception of that to the inferior oblique, which penetrates the hinder border of its muscle.

**Varieties.**—The third nerve has been seen in a few cases giving a branch to the external rectus (Cruveilhier, Fäsebeck, C. Krause), and in one instance a branch of the third supplied the place of the sixth nerve which was wanting (Generali). The branch to the inferior oblique muscle was seen by Arnold to pass through the lower part of the lenticular ganglion, and by Henle to pierce the inferior rectus.

POSITION OF CERTAIN NERVES AT THE CAVERNOUS SINUS, AND AS THEY ENTER THE ORBIT.—There are several nerves, besides the third, placed close together at the cavernous sinus, and entering the orbit through the sphenoidal fissure. To avoid repetition hereafter, the relative positions of these nerves may now be described. The nerves thus associated are the third, the fourth, the ophthalmic division of the fifth, and the sixth.

*At the cavernous sinus.*—In the dura mater which bounds the cavernous sinus on the outer side, the third and fourth nerves and the ophthalmic division of the fifth are placed, as regards one another, in their numerical order both from above downwards and from within outwards. The sixth nerve is placed separately from the others close to the carotid artery on the floor of the sinus, and internally to the ophthalmic nerve. Near the sphenoidal fissure, through which they enter the orbit, the relative position of the nerves is changed, the sixth nerve being here close to the rest, and their number is augmented by the division of the third and the ophthalmic nerves—the former into two, the latter into three parts.

*In the sphenoidal fissure.*—The fourth and the frontal and lachrymal branches of the fifth, which are here higher than the rest, lie on the same level, the fourth being the nearest to the inner side, and enter the orbit above the muscles. The remaining nerves pass between the heads of the external rectus muscle, in the following order from above downwards; the upper division of the third, the nasal branch of the fifth, the lower division of the third, and, lowest of all, the sixth.

## IV.—TROCHLEAR NERVE.

The fourth, trochlear, or pathetic nerve is the smallest of the cranial nerves, and has the longest course within the cranial cavity. It is distributed solely to the superior oblique muscle of the eye.

Taking its superficial origin close below the corpora quadrigemina from the upper part of the valve of Vieussens, the fourth nerve is directed at first outwards across the superior peduncle of the cerebellum, and then turns forwards round the outer side of the crus cerebri (fig. 311), lying parallel to and between the posterior cerebral and superior cerebellar arteries. It enters an aperture in the dura mater immediately beneath the free margin of the tentorium, a little behind the posterior clinoid process, and runs forwards in the outer wall of the cavernous sinus, resting against the upper margin of the ophthalmic nerve, and crossing the third obliquely on its outer side from below upwards, to the inner end of the sphenoidal fissure. Passing into the orbit above the external rectus muscle, it inclines inwards over the levator palpebræ and superior rectus, and finally enters the superior oblique muscle on its upper surface, and close to its outer border.

Fig. 316.

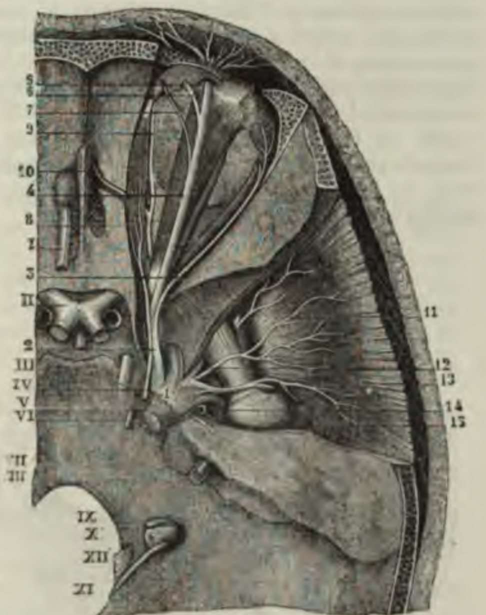


Fig. 316.—View from above of the uppermost nerves of the orbit, the Gasserian ganglion, &c. (from Sappey, after Hirschfeld and Leveillé). $\frac{2}{3}$

I, olfactory tract, passing forwards into the bulb; II, optic commissure; III, oculomotor; IV, trochlear nerve; V, large root of the fifth nerve, a small portion of the lesser root is seen below it; VI, sixth nerve; VII, facial; VIII, auditory; IX, glosso-pharyngeal; X, pneumo-gastric; XI, spinal accessory; XII, hypoglossal; 1, Gasserian ganglion; 2, ophthalmic nerve; 3, lachrymal nerve; 4, frontal; 5, external, 6, internal branch of the supraorbital nerve; 7, supratrochlear nerve; 8, nasal nerve; 9, its infratrochlear branch; 10, nasal nerve, passing through the internal orbital canal; 11, anterior deep temporal proceeding from the buccal nerve; 12, middle deep temporal; 13, posterior deep temporal arising from the masseteric; 14, origin of the auriculo-temporal; 15, great superficial petrosal nerve.

While lodged in the outer wall of the sinus, the fourth nerve is connected with the sympathetic on the carotid artery, and according to Rosenthal it is also joined by a filament from the ophthalmic nerve.

**Varieties.**—The fourth nerve has been observed in several cases sending a branch forwards to the orbicularis palpebrarum muscle, or to join the supratrochlear, the infratrochlear, or the nasal nerve. A communication with the frontal nerve is recorded by Berté.

## V.—TRIFACIAL NERVE.

The fifth, trifacial, or trigeminal nerve is the largest of the cranial nerves, and resembles a spinal nerve, in the circumstance that it arises by separate sensory and motor roots, and also that the sensory fibres pass through a ganglion while the motor do not. Its sensory division, which is much the larger, imparts common sensibility to the face and the fore part of the head, as well as to the eye, the nose, the ear, and the mouth, inclu ing the greater portion of the tongue ; it may possibly also confer the power of taste upon the fore part of the latter organ. The motor root supplies chiefly the muscles of mastication.

The two roots of the nerve spring from the side of the pons Varolii, where the transverse fibres of the latter are prolonged into the middle peduncle of the cerebellum, and much nearer its upper than its lower border. The small root issues above the large one, and the two are separated from one another by a small band of the cross fibres of the pons. From this origin, the two roots are directed forwards beneath the anterior extremity of the tentorium to the middle fossa of the base of the skull, and enter a recess in the dura mater over the summit of the petrous part of the temporal bone. Here the large root becomes expanded, and its funiculi divide and unite so as to form a plexiform network which is continued into the Gasserian ganglion. The small root inclines downwards on the inner side of the large root, and then passes outwards beneath the ganglion, without its fibres being incorporated in any way with the latter, to join below the foramen ovale the lowest of the three trunks issuing from the ganglion.

Fig. 317.

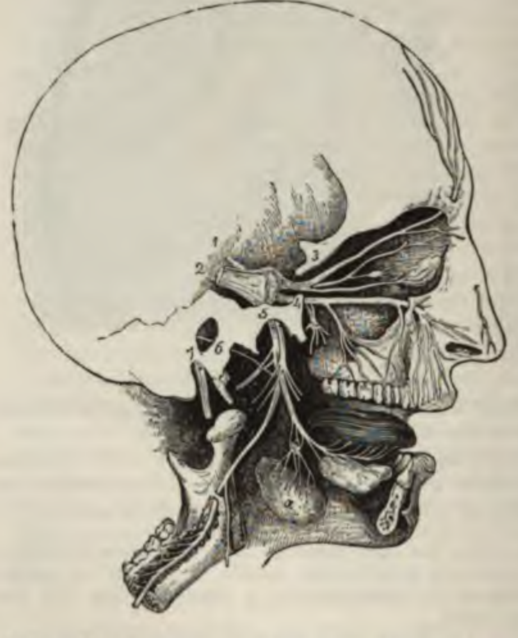


Fig. 317.—GENERAL PLAN OF THE BRANCHES OF THE FIFTH PAIR (after a sketch by Charles Bell). ⅓

1, small root of the fifth nerve ; 2, large root, passing forwards into the Gasserian ganglion ; 3, placed on the bone above the ophthalmic nerve, which is dividing into the frontal, lachrymal, and nasal branches, the latter connected with the ophthalmic ganglion ; 4, placed on the bone close to the foramen rotundum, marks the superior maxillary division, which is connected below with the spheno-palatine ganglion, and passes forwards to the infraorbital foramen ; 5, placed on the bone over the foramen ovale, marks the inferior maxillary nerve, giving off the auriculo-temporal and muscular branches, and continued by the inferior dental to the lower jaw, and by the lingual to the tongue ; *a*, submaxillary gland, the submaxillary ganglion placed above it in connection with the lingual nerve ; 6, chorda tympani ; 7, facial nerve, issuing from the stylo-mastoid foramen.

The *ganglion of the fifth nerve* or *Gasserian ganglion* (ganglion semilunare) occupies a depression on the upper part of the petrous portion of the temporal bone, near the apex, and is somewhat crescentic in form, the convexity being turned forwards. It is flattened, and striated on the surface. On its inner side the ganglion is joined by filaments from the carotid plexus of the sympathetic nerve, and, according to some anatomists, it furnishes from its back part filaments to the dura mater.

From the fore part, or convex border of the Gasserian ganglion, proceed the three large divisions of the nerve. The highest (*first* or *ophthalmic trunk*) enters the orbit; the second, the *superior maxillary nerve*, is continued forwards to the face between the orbit and mouth; and the third, the *inferior maxillary nerve*, is distributed chiefly to the external ear, the tongue, the lower teeth, the face below the mouth, and the muscles of mastication. The first two trunks proceed exclusively from the ganglion and are entirely sensory, while the third or inferior maxillary trunk, derived principally from the ganglion, has associated with it also the whole of the fibres of the motor root, and thus distributes both motor and sensory branches.

## I.—OPHTHALMIC NERVE.

The ophthalmic nerve, or first division of the fifth, the smallest of the three offsets from the Gasserian ganglion, is flattened from side to side, and measures about an inch in length. It is directed forwards and upwards in the outer wall of the cavernous sinus, in company with the third and fourth nerves, towards the sphenoidal fissure, where it ends in branches which pass through the orbit to the surface of the head and to the nasal fossa. In its course forwards, the ophthalmic nerve is joined by filaments from the cavernous plexus of the sympathetic.

BRANCHES.—A small *recurrent* branch arises from the ophthalmic trunk near the Gasserian ganglion and, running backwards across the fourth nerve, to which it generally adheres closely for some distance, ramifies between the layers of the tentorium.

Farther forwards the ophthalmic nerve gives off three slender offsets which join respectively the third, fourth, and sixth nerves as they enter the orbit (L. Rosenthal, Wiener Sitzungsber., 1878).

The terminal branches resulting from the division of the ophthalmic nerve close to the orbit are the nasal, which is usually the first to arise and springs from the inner and lower part of the trunk, the frontal and the lachrymal. These branches are transmitted separately through the sphenoidal fissure, and are continued through the orbit (after supplying some filaments to the eyeball and the lachrymal gland) to their final distribution in the nose, the eyelids and the integument of the forehead.

**Lachrymal nerve.**—The lachrymal nerve (fig. 316, 3) is external to the frontal at its origin, and is contained in a separate sheath of dura mater. In the orbit it passes along the outer part, above the external rectus muscle, to the outer and upper angle of the cavity. Near the lachrymal gland, the nerve has a connecting filament with the orbital branch of the superior maxillary nerve; and when in close apposition with the gland, it gives many filaments to that body and to the conjunctiva. Finally, the lachrymal nerve penetrates the palpebral ligament externally, and ends in the upper eyelid, the terminal ramifications being joined by twigs from the facial nerve.

**Varieties.**—The lachrymal nerve is occasionally smaller than usual, being reinforced by a twig from the orbital branch of the superior maxillary, and it been seen replaced entirely by an offset of the latter nerve (Turner, Hyrtl.). the other hand, the lachrymal nerve has been found sending an offset thr the malar bone in the place of the temporal branch of the superior maxillary nerve, which was absent (G. D. T.).

The lachrymal branch sometimes appears to be derived in part from the fourth nerve, but in such cases the additional root is composed of fibres that have passed over from the ophthalmic to the fourth while these nerves are contained in the outer wall of the cavernous sinus (Cruveilhier).

**Frontal nerve.**—The frontal nerve (fig. 316, 4), the largest division of the ophthalmic, also enters the orbit above the muscles, and runs forwards between the elevator of the upper eyelid and the periosteum. About the middle of the orbit it divides into two branches, supratrochlear and supraorbital.

(*a*) The *supratrochlear nerve*, much the smaller of the two branches, inclines inwards towards the pulley of the superior oblique muscle, close to which it sends a filament downwards to communicate in a loop with the infratrochlear branch of the nasal nerve, and then leaves the orbit between the orbicularis palpebrarum muscle and the bone. In this position, the nerve gives twigs to the skin and conjunctiva of the upper eyelid, and finally it turns upwards, dividing into branches which perforate the orbicularis and frontalis muscles, and are distributed to the integument of the lower and mesial part of the forehead.

(*b*) The *supraorbital nerve* is the continuation of the frontal nerve, and leaves the orbit by the supraorbital notch or foramen. It divides into two branches, inner and outer, which ascend on the forehead beneath the frontalis muscle, and are distributed by numerous slender ramifications to the skin of the fore and upper parts of the scalp. The outer branch is the larger and extends backwards nearly to the lambdoid suture; the inner branch reaches but a little way over the parietal bone. Small branches also pass to the pericranium, and as the nerve emerges from the orbit twigs are sent downwards to the upper eyelid.

The primary division of the supraorbital nerve often takes place before it issues from the orbit, and in that case only the larger branch passes through the supraorbital notch, the smaller one being placed more internally, and not unfrequently traversing a second slighter notch (*frontal notch*, Henle) in the orbital margin (fig. 316, 5, 6).

The branches of the supraorbital nerve, and the same is the case with all the cutaneous offsets of the fifth, form communications with the adjacent ramifications of the facial nerve; in this way sensory fibres derived from the fifth nerve may be conveyed to the surrounding muscles.

**Nasal nerve.**—The nasal nerve (oculo-nasal) enters the orbit between the heads of the external rectus muscle, and between the two divisions of the third nerve. It then inclines inwards over the optic nerve, passing beneath the superior rectus and superior oblique muscles, to the inner side of the orbit, and leaves that cavity by the anterior internal orbital canal. In this part of its course it furnishes a slender branch to the ophthalmic ganglion, one or two filaments (long ciliary) directly to the eyeball, and a considerable infratrochlear branch, which arises just before the nerve enters its canal on the inner side of the orbit.

Arrived in the cranial cavity, the nerve is directed forwards in a groove at the outer edge of the cribriform plate of the ethmoid bone to a small canal between the fore part of the plate and the frontal bone (p. 47), through which it descends to the nasal fossa. Here it gives off internal or septal and external branches to the mucous membrane of the fore part of the nasal fossa, and is then continued downwards in the groove on the back of the nasal bone, to terminate as the anterior or superficial branch in the integument of the lower part of the nose.

(*a*) The *branch to the ophthalmic ganglion*, very slender, and from a quarter to half an inch in length, arises generally between the heads of the external rectus. It lies on the outer side of the optic nerve, and enters the upper and back part of the ganglion, constituting its *long root*.

(*b*) The *long ciliary nerves* are situated on the inner side of the optic nerve; they join one or more of the short ciliary branches from the ophthalmic ganglion, and, after perforating the sclerotic coat of the eye, are distributed in the same manner as those nerves.

(*c*) The *infratrochlear nerve* runs forwards along the inner side of the orbit, below the superior oblique muscle, and parallel to the supratrochlear nerve, from which it receives, near the pulley of the oblique muscle, a filament of connection. The nerve is then continued below the pulley to the inner angle of the eye, and ends in filaments which supply the conjunctiva, the caruncle, and the lachrymal sac, as well as the integument of the eyelids and root of the nose (fig. 326, 22).

(*d*) The *internal* or *septal branch* (fig. 314, 2), supplies the pituitary membrane over the fore part of the septum, extending dowards nearly as far as the opening of the nostril.

(*e*) The *external branch* (fig. 321, 2), often represented by two or three filaments, is distributed to the mucous membrane of the fore part of the outer wall of the nasal fossa, including the anterior ends of the middle and lower turbinate bones.

(*f*) The *anterior* or *superficial branch* (fig. 326, 24) issues between the nasal bone and the upper lateral cartilage of the nose, and runs downwards under cover of the compressor naris muscle to the tip of the nose, supplying the skin of the lower part of the organ.

**Varieties.**—The nasal nerve occasionally (frequently, Krause) gives filaments to the superior and internal recti muscles. A branch to the levator palpebræ superioris has also been met with (Fäsebeck). Offsets from the nasal nerve, as it traverses the anterior internal orbital canal, to the frontal sinus and ethmoidal cells are described by Meckel and Langenbeck, and a *spheno-ethmoidal* (Luschka) or *posterior ethmoidal* (Krause) branch is said to pass through the posterior internal orbital canal to the mucous membrane of the sphenoidal sinus and posterior ethmoidal cells.

SUMMARY.—The first division of the fifth nerve is altogether sensory in function. It furnishes branches to the eyeball and the lachrymal gland; to the mucous membrane of the nose and eyelids; to the integument of the nose, the upper eyelid, the forehead, and the upper part of the hairy scalp. It has communications with the third, fourth, and sixth nerves, with numerous branches of the facial, and with the sympathetic.

## Ophthalmic Ganglion.

There are four small ganglia connected with the divisions of the fifth nerve: the ophthalmic ganglion with the first, Meckel's ganglion with the second, and the otic and submaxillary ganglia with the third. These ganglia, besides receiving branches from the sensory part of the fifth, are each connected with a motor nerve from the third, the fifth, or the facial, and with twigs from the sympathetic; and the nerves thus joining the ganglia are named their roots.

The **ophthalmic, ciliary,** or **lenticular ganglion** serves as a centre for the supply of nerves—motor, sensory, and sympathetic—to the eyeball. It is a small reddish body, compressed laterally and somewhat four-sided, and measures about a line from before back. It is situated at the back of the orbit, between the outer rectus muscle and the optic nerve, and generally in contact with the ophthalmic artery; it is joined behind by branches from the fifth, the third, and the sympathetic nerves; while from its fore part proceed the short ciliary nerves to the eyeball.

Fig. 318.

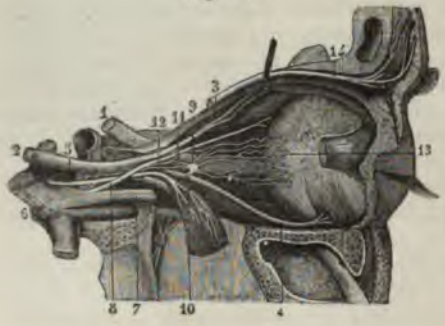


Fig. 318.—NERVES OF THE ORBIT FROM THE OUTER SIDE (from Sappey, after Hirschfeld and Leveillé). $\frac{3}{4}$

The external rectus muscle has been divided and turned down: 1, optic nerve; 2, trunk of the third nerve; 3, its upper division passing into the levator palpebræ and superior rectus; 4, its long lower branch to the inferior oblique muscle; 5, the sixth nerve joined by twigs from the sympathetic; 6, Gasserian ganglion; 7, ophthalmic nerve; 8, its nasal branch; 9, ophthalmic ganglion; 10, its short, 11, its long, and 12, its sympathetic root; 13, short ciliary nerves; 14, supraorbital nerve.

UNION OF THE GANGLION WITH NERVES: ITS ROOTS.—The posterior border of the ganglion receives three nerves. One of these, the *long* or *sensory root*, a slender filament from the nasal branch of the ophthalmic trunk, joins the upper part of this border. Another branch, the *short* or *motor root*, much thicker and shorter than the preceding, and sometimes divided into two parts, is derived from the branch of the third nerve to the inferior oblique muscle, and is connected with the lower part of the ganglion. The *middle* or *sympathetic root* is a very small nerve which emanates from the cavernous plexus of the sympathetic, and reaches the ganglion close to the long upper root: these two nerves are frequently conjoined before reaching the ganglion. The ganglion is sometimes very small, probably from the nerve cells being distributed along the nerves which are connected with it.

BRANCHES OF THE GANGLION.—From the fore part of the ganglion arise six or eight *short ciliary nerves*, which undergo division as they pass forwards, so that they form from twelve to twenty fine filaments as they reach the eyeball. They are disposed in two bundles, springing from the upper and lower angles of the ganglion, and being placed, the one set above, the other below the optic nerve. The lower set is the more numerous, and is accompanied by the long ciliary nerves (from the nasal), with which one or more of these branches are joined. Having entered the eyeball by apertures in the back part of the sclerotic coat, the nerves are lodged in grooves on its inner surface, and are finally distributed to the ciliary muscle, the iris and the cornea (see the anatomy of the eye in Vol. II.).

**Varieties.**—Additional roots to the ophthalmic ganglion have been observed by many anatomists, derived from the upper division of the third nerve, from [illegible] the back of the nasal bone, to terminate as the anterior or superficial branch in the integument of the lower part of the nose.

(*a*) The *branch to the ophthalmic ganglion*, very slender, and from a quarter to half an inch in length, arises generally between the heads of the external rectus. It lies on the outer side of the optic nerve, and enters the upper and back part of the ganglion, constituting its *long root*.

(*b*) The *long ciliary nerves* are situated on the inner side of the optic nerve; they join one or more of the short ciliary branches from the ophthalmic ganglion, and, after perforating the sclerotic coat of the eye, are distributed in the same manner as those nerves.

(*c*) The *infratrochlear nerve* runs forwards along the inner side of the orbit, below the superior oblique muscle, and parallel to the supratrochlear nerve, from which it receives, near the pulley of the oblique muscle, a filament of connection. The nerve is then continued below the pulley to the inner angle of the eye, and ends in filaments which supply the conjunctiva, the caruncle, and the lachrymal sac, as well as the integument of the eyelids and root of the nose (fig. 326, 22).

(*d*) The *internal* or *septal branch* (fig. 314, 2), supplies the pituitary membrane over the fore part of the septum, extending dowards nearly as far as the opening of the nostril.

(*e*) The *external branch* (fig. 321, 2), often represented by two or three filaments, is distributed to the mucous membrane of the fore part of the outer wall of the nasal fossa, including the anterior ends of the middle and lower turbinate bones.

(*f*) The *anterior* or *superficial branch* (fig. 326, 24) issues between the nasal bone and the upper lateral cartilage of the nose, and runs downwards under cover of the compressor naris muscle to the tip of the nose, supplying the skin of the lower part of the organ.

**Varieties.**—The nasal nerve occasionally (frequently, Krause) gives filaments to the superior and internal recti muscles. A branch to the levator palpebræ superioris has also been met with (Fäsebeck). Offsets from the nasal nerve, as it traverses the anterior internal orbital canal, to the frontal sinus and ethmoidal cells are described by Meckel and Langenbeck, and a *spheno-ethmoidal* (Luschka) or *posterior ethmoidal* (Krause) branch is said to pass through the posterior internal orbital canal to the mucous membrane of the sphenoidal sinus and posterior ethmoidal cells.

SUMMARY.—The first division of the fifth nerve is altogether sensory in function. It furnishes branches to the eyeball and the lachrymal gland; to the mucous membrane of the nose and eyelids; to the integument of the nose, the upper eyelid, the forehead, and the upper part of the hairy scalp. It has communications with the third, fourth, and sixth nerves, with numerous branches of the facial, and with the sympathetic.

## Ophthalmic Ganglion.

There are four small ganglia connected with the divisions of the fifth nerve: the ophthalmic ganglion with the first, Meckel's ganglion with the second, and the otic and submaxillary ganglia with the third. These ganglia, besides receiving branches from the sensory part of the fifth, are each connected with a motor nerve from the third, the fifth, or the facial, and with twigs from the sympathetic; and the nerves thus joining the ganglia are named their roots.

nerve to the orbit, and two spheno-palatine branches descend to join Meckel's ganglion; while the nerve is in contact with the upper maxilla, it furnishes the superior dental or alveolar branches; and on the face are the terminal branches already indicated.

**Orbital branch.**—The orbital or temporo-malar branch, a small cutaneous nerve, enters the orbit by the spheno-maxillary fissure, and immediately divides into two branches (temporal and malar), which pierce the malar bone, and are distributed to the temple and the prominent part of the cheek.

(*a*) The *temporal branch* is directed upwards in a groove on the outer wall of the orbit, and leaves this cavity by the temporal canal in the malar bone (p. 53). While still in the orbit, it is joined by a communicating filament (in some cases, by two filaments) from the lachrymal nerve. The nerve is then inclined upwards in the temporal fossa between the bone and the temporal muscle, and perforating the aponeurosis over the muscle nearly an inch above the zygoma, ends in cutaneous filaments over the fore part of the temporal region. The cutaneous ramifications are united with the facial nerve, and sometimes with the auriculo-temporal branch of the third division of the fifth.

(*b*) The *malar branch* lies at first in the loose fat in the lower angle of the orbit, and is continued to the face through the malar canal of the malar bone, where it is frequently divided into two filaments. It is distributed to the skin over the malar bone. In the prominent part of the cheek, this nerve communicates with the facial nerve.

**Varieties.**—The temporo-malar nerve is subject to frequent deviations from the arrangement above described. Thus, either branch may be smaller than usual, or even absent, in which case the other division of the nerve may be distributed over a larger area, or the temporal branch may be reinforced or replaced by the lachrymal nerve, the malar branch by the infraorbital nerve. The temporal branch, instead of perforating the malar bone, frequently passes into the temporal fossa through the anterior end of the spheno-maxillary fissure.

The **superior dental** or **alveolar nerves** are, as a rule, three in number, anterior, middle, and posterior, but the middle is sometimes conjoined with the anterior, while the posterior is frequently represented by two separate offsets.

The *posterior superior dental nerve* arises from the superior maxillary trunk before it enters the infraorbital groove, and immediately divides into two branches (often separate at their origin), which descend with the posterior dental artery on the zygomatic surface of the upper jaw. They send small external filaments to the gum and the adjacent part of the mucous membrane of the cheek, and then enter the posterior dental canals to terminate in offsets to the molar teeth and the lining membrane of the antrum.

**Variety.**—The posterior dental nerve has been seen in a few instances of large size, and replacing the buccal nerve, which was absent as a branch of the inferior maxillary, in the supply of the cheek.

The *middle superior dental nerve* leaves the superior maxillary in the hinder part of the infraorbital canal, and is directed downwards and forwards in a special canal in the outer wall of the antrum to the bicuspid teeth.

The *anterior superior dental nerve* is the largest of the three. Arising near the infraorbital foramen, it descends in its canal in the front wall of the antrum, and divides into *dental* branches for the incisor and canine teeth, and a *nasal* branch, which supplies the pituitary membrane in the fore part of the inferior meatus and the adjoining part of the floor of the nasal fossa.

Fig. 320.

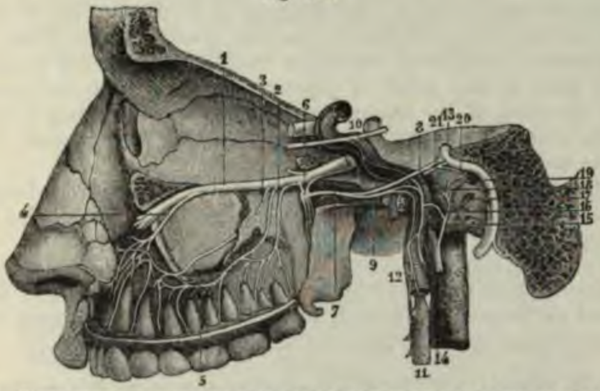


Fig. 320.—DEEP VIEW OF THE SUPERIOR MAXILLARY NERVE AND THE SPHENO-PALATINE GANGLION, &c. (from Sappey, after Hirschfeld and Leveillé). $\frac{2}{3}$

1, superior maxillary nerve; 2, posterior superior dental; 3, middle superior dental; 4, anterior superior dental; 5, superior dental plexus; 6, spheno-palatine ganglion; 7, Vidian nerve; 8, its great superficial petrosal branch; 9, its great deep petrosal branch; 10, a part of the sixth nerve, receiving twigs from the carotid plexus of the sympathetic; 11, superior cervical sympathetic ganglion; 12, its ascending branch; 13, facial nerve; 14, glosso-pharyngeal nerve; 15, its tympanic branch; 16, twig joining the sympathetic; 17, filament to the fenestra rotunda; 18, filament to the Eustachian tube; 19, filament to the fenestra ovalis; 20, small superficial petrosal nerve.

The three dental nerves communicate so as to form loops with one another while they are contained in their bony canals, and from these loops other branches spring, which join again and give rise to a plexus (*superior dental plexus*) from which the minute terminal filaments proceed to the teeth and gum.

**Facial branches.**—The facial branches are divisible into palpebral, nasal, and labial sets.

The *inferior palpebral* branches, generally an inner and an outer, ascend from the termination of the infraorbital nerve to supply the skin and conjunctiva of the lower eyelid in its whole breadth.

The *lateral nasal* branches, two or three in number, are directed inwards between the fibres of the levator labii superioris alæque nasi muscle to the skin of the side of the nose.

The *superior labial* branches, the largest of the terminal offsets of the superior maxillary nerve, and three or four in number, pass downwards between the elevator muscles of the upper lip and of the angle of the mouth. Ramifying as they descend, and giving off branches to supply the integument of the fore part of the cheek, they end in the skin and mucous membrane of the upper lip.

Below the orbit, the terminal branches of the superior maxillary nerve are joined by considerable branches of the facial nerve, the union between the two being named the *infraorbital plexus.*

### Spheno-Palatine Ganglion.

The spheno-palatine ganglion, also named Meckel's or the nasal ganglion, is deeply placed in the spheno-maxillary fossa, close to the spheno-palatine foramen. It receives the two spheno-palatine branches which descend together from the superior maxillary nerve as it crosses the top of the fossa. It is of a reddish-grey colour, triangular in form, and convex on the outer surface. Its diameter is about the fifth of an inch. The grey or ganglionic substance does not involve all the fibres of the spheno-palatine branches of the upper maxillary nerve, but is placed at the back part, at the point of junction of the Vidian nerve, so that many of the fibres of the spheno-palatine nerves proceeding to the nose and palate pass to their destination without being incorporated with the ganglionic mass.

Branches proceed from the ganglion upwards to the orbit, downwards to the palate, inwards to the nose, and backwards through the Vidian and pterygo-palatine canals.

ASCENDING BRANCHES.—These consist of three or more very small twigs, which reach the orbit by the spheno-maxillary fissure, and are distributed to the periosteum and, according to Luschka, to the mucous membrane of the posterior ethmoidal and sphenoidal sinuses.

Bock and Valentin describe a branch ascending from the ganglion to the sixth nerve; Tiedemann, one to the lower angle of the ophthalmic ganglion. The filaments described by Hirzel as ascending to the optic nerve most probably join the ciliary twigs which surround that nerve.

DESCENDING BRANCHES.—These are three in number,—the large, the small, and the external palatine nerves, and are in great part continued directly from the spheno-palatine branches of the superior maxillary.

(*a*) The *large* or *anterior palatine nerve* descends in the palato-maxillary canal, and divides in the roof of the mouth into branches which are received into grooves in the hard palate, and extend forwards nearly to the incisor teeth. In the mouth it supplies the inner side of the gum, the glands, and the mucous membrane of the hard palate, and joins in front with the naso-palatine nerve. When entering its canal, this palatine nerve gives a nasal branch which ramifies on the middle and lower spongy bones; and a little before leaving the canal, another branch is supplied to the membrane covering the lower spongy bone: these are the *inferior nasal branches*.

(*b*) The *small* or *posterior palatine nerve* enters, with a small artery, the lesser palatine canal, and is conducted to the soft palate, the tonsil, and the uvula. Through it are supplied also the levator palati and azygos uvulæ muscles.

[illegible] The *external palatine nerve*, the smallest of the series, courses
[illegible] he external palatine canal between the maxilla and the tuber-
[illegible] he palate bone, to be distributed to the tonsil and the outer
[illegible] e soft palate. This nerve is occasionally wanting.

[illegible] AL BRANCHES.—These consist of the naso-palatine, and the
[illegible] al branches, which ramify in the lining membrane of the nasal
[illegible] d adjoining sinuses.

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asal [illegible] heno-palatine foramen. Some are prolonged to
[illegible] part of the septum, and the remainder ramify

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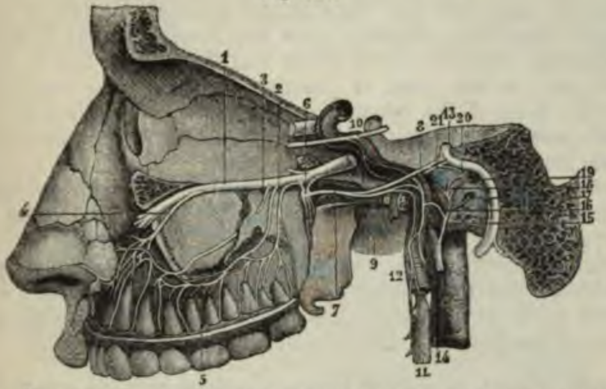
Fig. 320.



ig. 320.—DEEP VIEW OF THE SUPERIOR MAXILLARY NERVE AND THE SPHENO-PALATINE GANGLION, &c. (from Sappey, after Hirschfeld and Leveillé). $\frac{3}{5}$

1, superior maxillary nerve; 2, posterior superior dental; 3, middle superior dental; 4, anterior superior dental; 5, superior dental plexus; 6, spheno-palatine ganglion; 7, Vidian nerve; 8, its great superficial petrosal branch; 9, its great deep petrosal branch; 10, a part of the sixth nerve, receiving twigs from the carotid plexus of the sympathetic; 11, superior cervical sympathetic ganglion; 12, its ascending branch; 13, facial nerve; 14, glosso-pharyngeal nerve; 15, its tympanic branch; 16, twig joining the sympathetic; 17, filament to the fenestra rotunda; 18, filament to the Eustachian tube; 19, filament to the fenestra ovalis; 20, small superficial petrosal nerve.

The three dental nerves communicate so as to form loops with one another while they are contained in their bony canals, and from these loops other branches spring, which join again and give rise to a plexus (*superior dental plexus*) from which the minute terminal filaments proceed to the teeth and gum.

**Facial branches.**—The facial branches are divisible into palpebral, nasal, and labial sets.

The *inferior palpebral* branches, generally an inner and an outer, ascend from the termination of the infraorbital nerve to supply the skin and conjunctiva of the lower eyelid in its whole breadth.

The *lateral nasal* branches, two or three in number, are directed inwards between the fibres of the levator labii superioris alæque nasi muscle to the skin of the side of the nose.

The *suverior labial* branches, the largest of the terminal offsets of the superior maxillary nerve, and three or four in number, pass downwards between the elevator muscles of the upper lip and of the angle of the mouth. Ramifying as they descend, and giving off branches to supply the integument of the fore part of the cheek, they end in the skin and mucous membrane of the upper lip.

Below the orbit, the terminal branches of the superior maxillary nerve are joined by considerable branches of the facial nerve, the union between the two being named the *infraorbital plexus.*

### Spheno-Palatine Ganglion.

The spheno-palatine ganglion, also named Meckel's or the nasal ganglion, is deeply placed in the spheno-maxillary fossa, close to the spheno-palatine foramen. It receives the two spheno-palatine branches which descend together from the superior maxillary nerve as it crosses the top of the fossa. It is of a reddish-grey colour, triangular in form, and convex on the outer surface. Its diameter is about the fifth of an inch. The grey or ganglionic substance does not involve all the fibres of the spheno-palatine branches of the upper maxillary nerve, but is placed at the back part, at the point of junction of the Vidian nerve, so that many of the fibres of the spheno-palatine nerves proceeding to the nose and palate pass to their destination without being incorporated with the ganglionic mass.

Branches proceed from the ganglion upwards to the orbit, downwards to the palate, inwards to the nose, and backwards through the Vidian and pterygo-palatine canals.

Ascending branches.—These consist of three or more very small twigs, which reach the orbit by the spheno-maxillary fissure, and are distributed to the periosteum and, according to Luschka, to the mucous membrane of the posterior ethmoidal and sphenoidal sinuses.

Bock and Valentin describe a branch ascending from the ganglion to the sixth nerve; Tiedemann, one to the lower angle of the ophthalmic ganglion. The filaments described by Hirzel as ascending to the optic nerve most probably join the ciliary twigs which surround that nerve.

Descending branches.—These are three in number,—the large, the small, and the external palatine nerves, and are in great part continued directly from the spheno-palatine branches of the superior maxillary.

(*a*) The *large* or *anterior palatine nerve* descends in the palato-maxillary canal, and divides in the roof of the mouth into branches which are received into grooves in the hard palate, and extend forwards nearly to the incisor teeth. In the mouth it supplies the inner side of the gum, the glands, and the mucous membrane of the hard palate, and joins in front with the naso-palatine nerve. When entering its canal, this palatine nerve gives a nasal branch which ramifies on the middle and lower spongy bones; and a little before leaving the canal, another branch is supplied to the membrane covering the lower spongy bone: these are the *inferior nasal branches.*

(*b*) The *small* or *posterior palatine nerve* enters, with a small artery, the lesser palatine canal, and is conducted to the soft palate, the tonsil, and the uvula. Through it are supplied also the levator palati and azygos uvulæ muscles.

(*c*) The *external palatine nerve*, the smallest of the series, courses through the external palatine canal between the maxilla and the tuberosity of the palate bone, to be distributed to the tonsil and the outer part of the soft palate. This nerve is occasionally wanting.

Internal branches.—These consist of the naso-palatine, and the upper nasal branches, which ramify in the lining membrane of the nasal fossæ and adjoining sinuses.

The *upper nasal* are very small branches, and enter the back part of the nasal fossa by the spheno-palatine foramen. Some are prolonged to the upper and posterior part of the septum, and the remainder ramify n the membrane covering the upper two spongy bones, and in that ning the posterior ethmoidal cells.

The *naso-palatine nerve*, nerve of Cotunnius (Scarpa) (fig. 314, 3), ong and slender, leaves the inner side of the ganglion with the preceding branches, and after crossing the roof of the nasal fossa is directed downwards and forwards on the septum nasi, between the periosteum and the pituitary membrane, towards the anterior palatine canal. The nerves of opposite sides descend to the palate through the mesial subdivisions of the canal, called the foramina of Scarpa, the nerve of the right side usually behind that of the left (see p. 50). In the lower common foramen the two naso-palatine nerves are connected with each other in a fine plexus; and they end in several filaments, which are distributed to the mucous membrane behind the incisor teeth, and communicate with the great palatine nerve. In its course along the septum, small filaments are furnished from the naso-palatine nerve to the pituitary membrane.

Fig. 321.

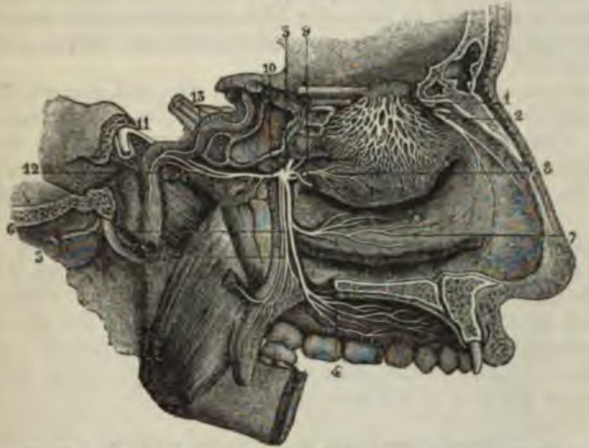


Fig. 321.—NERVES OF THE NOSE AND THE SPHENO-PALATINE GANGLION FROM THE INNER SIDE (from Sappey, after Hirschfeld and Leveillé). ⅔

1, network of the external branches of the olfactory nerve; 2, nasal nerve, giving its external branch to the outer wall of the nose; the septal branch is cut short; 3, spheno-palatine ganglion; 4, ramification of the large palatine nerve; 5, small, and 6, external palatine nerve; 7, inferior nasal branch; 8, superior nasal branch; 9, naso-palatine nerve cut short; 10, Vidian nerve; 11, great superficial petrosal nerve; 12, great deep petrosal nerve; 13, the sympathetic nerves ascending on the internal carotid artery.

POSTERIOR BRANCHES.—The branches directed backwards from the spheno-palatine ganglion are the Vidian and pharyngeal nerves.

The *Vidian nerve*, arising from the back part of the ganglion, which seems to be prolonged into it, passes backwards through the Vidian canal, and after emerging from this divides in the foramen lacerum into two branches: one of these, the *great superficial petrosal nerve*, joins the facial, while the other, the *great deep petrosal*, communicates with the sympathetic. While the Vidian nerve is in its canal, it gives some small *nasal* branches, which supply the membrane of the back part of the roof of the nose and septum, as well as the membrane covering the end of the Eustachian tube.

### Spheno-Palatine Ganglion.

The spheno-palatine ganglion, also named Meckel's or the nasal ganglion, is deeply placed in the spheno-maxillary fossa, close to the spheno-palatine foramen. It receives the two spheno-palatine branches which descend together from the superior maxillary nerve as it crosses the top of the fossa. It is of a reddish-grey colour, triangular in form, and convex on the outer surface. Its diameter is about the fifth of an inch. The grey or ganglionic substance does not involve all the fibres of the spheno-palatine branches of the upper maxillary nerve, but is placed at the back part, at the point of junction of the Vidian nerve, so that many of the fibres of the spheno-palatine nerves proceeding to the nose and palate pass to their destination without being incorporated with the ganglionic mass.

Branches proceed from the ganglion upwards to the orbit, downwards to the palate, inwards to the nose, and backwards through the Vidian and pterygo-palatine canals.

Ascending branches.—These consist of three or more very small twigs, which reach the orbit by the spheno-maxillary fissure, and are distributed to the periosteum and, according to Luschka, to the mucous membrane of the posterior ethmoidal and sphenoidal sinuses.

Bock and Valentin describe a branch ascending from the ganglion to the sixth nerve; Tiedemann, one to the lower angle of the ophthalmic ganglion. The filaments described by Hirzel as ascending to the optic nerve most probably join the ciliary twigs which surround that nerve.

Descending branches.—These are three in number,—the large, the small, and the external palatine nerves, and are in great part continued directly from the spheno-palatine branches of the superior maxillary.

(*a*) The *large* or *anterior palatine nerve* descends in the palato-maxillary canal, and divides in the roof of the mouth into branches which are received into grooves in the hard palate, and extend forwards nearly to the incisor teeth. In the mouth it supplies the inner side of the gum, the glands, and the mucous membrane of the hard palate, and joins in front with the naso-palatine nerve. When entering its canal, this palatine nerve gives a nasal branch which ramifies on the middle and lower spongy bones; and a little before leaving the canal, another branch is supplied to the membrane covering the lower spongy bone: these are the *inferior nasal branches*.

(*b*) The *small* or *posterior palatine nerve* enters, with a small artery, the lesser palatine canal, and is conducted to the soft palate, the tonsil, and the uvula. Through it are supplied also the levator palati and azygos uvulæ muscles.

(*c*) The *external palatine nerve*, the smallest of the series, courses through the external palatine canal between the maxilla and the tuberosity of the palate bone, to be distributed to the tonsil and the outer part of the soft palate. This nerve is occasionally wanting.

Internal branches.—These consist of the naso-palatine, and the upper nasal branches, which ramify in the lining membrane of the nasal fossæ and adjoining sinuses.

The *upper nasal* are very small branches, and enter the back part of the nasal fossa by the spheno-palatine foramen. Some are prolonged to the upper and posterior part of the septum, and the remainder ramify in the membrane covering the upper two spongy bones, and in that lining the posterior ethmoidal cells.

The *naso-palatine nerve*, nerve of Cotunnius (Scarpa) (fig. 314, 3), long and slender, leaves the inner side of the ganglion with the preceding branches, and after crossing the roof of the nasal fossa is directed downwards and forwards on the septum nasi, between the periosteum and the pituitary membrane, towards the anterior palatine canal. The nerves of opposite sides descend to the palate through the mesial subdivisions of the canal, called the foramina of Scarpa, the nerve of the right side usually behind that of the left (see p. 50). In the lower common foramen the two naso-palatine nerves are connected with each other in a fine plexus; and they end in several filaments, which are distributed to the mucous membrane behind the incisor teeth, and communicate with the great palatine nerve. In its course along the septum, small filaments are furnished from the naso-palatine nerve to the pituitary membrane.

Fig. 321.

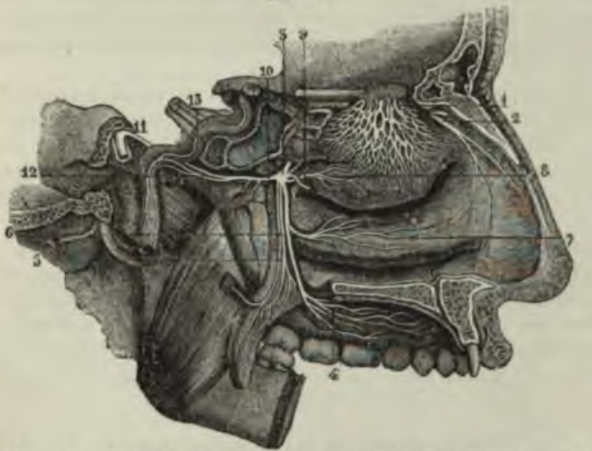


Fig. 321.—Nerves of the nose and the spheno-palatine ganglion from the inner side (from Sappey, after Hirschfeld and Leveillé). $\frac{2}{3}$

1, network of the external branches of the olfactory nerve; 2, nasal nerve, giving its external branch to the outer wall of the nose; the septal branch is cut short; 3, spheno-palatine ganglion; 4, ramification of the large palatine nerve; 5, small, and 6, external palatine nerve; 7, inferior nasal branch; 8, superior nasal branch; 9, naso-palatine nerve cut short; 10, Vidian nerve; 11, great superficial petrosal nerve; 12, great deep petrosal nerve; 13, the sympathetic nerves ascending on the internal carotid artery.

Posterior branches.—The branches directed backwards from the spheno-palatine ganglion are the Vidian and pharyngeal nerves.

The *Vidian nerve*, arising from the back part of the ganglion, which seems to be prolonged into it, passes backwards through the Vidian canal, and after emerging from this divides in the foramen lacerum into two branches: one of these, the *great superficial petrosal nerve*, joins the facial, while the other, the *great deep petrosal*, communicates with the sympathetic. While the Vidian nerve is in its canal, it gives some small *nasal* branches, which supply the membrane of the back part of the roof of the nose and septum, as well as the membrane covering the end of the Eustachian tube.

The *large superficial petrosal nerve*, entering the cranium on the outer side of the carotid artery and beneath the Gasserian ganglion, is directed backwards in a groove on the petrous portion of the temporal bone to the hiatus Fallopii, and is thus conducted to the aqueductus Fallopii, where it joins the geniculate ganglion of the facial nerve.

The *large deep petrosal nerve*, shorter than the other, is of a reddish colour and softer texture: it is directed backwards, and on the outer side of the carotid artery ends in the filaments of the sympathetic surrounding that vessel.

In accordance with the view taken of the ganglia connected with the fifth nerve (p. 557), the superficial and deep petrosal parts of the Vidian nerve may be regarded as the *motor* and *sympathetic roots* respectively of the spheno-palatine ganglion, the spheno-palatine nerves constituting its *sensory root*.

The *pharyngeal nerve* is inconsiderable in size, and, instead of emanating directly from the ganglion, is frequently derived altogether from the Vidian. This branch, when a separate nerve, springs from the back of the ganglion, enters the pterygo-palatine canal with an artery, and is lost in the lining membrane of the pharynx behind the Eustachian tube.

SUMMARY.—The superior maxillary nerve, with Meckel's ganglion, supplies the integument above and over the malar bone, and that of the lower eyelid, the side of the nose, and the upper lip; the upper teeth; the lining membrane of the nose; the membrane of the upper part of the pharynx, of the antrum of Highmore, and of the posterior ethmoidal cells; the soft palate, tonsil, and uvula, and the glandular and mucous structures of the roof of the mouth.

### III.—INFERIOR MAXILLARY NERVE.

The lower maxillary nerve, the third and largest division of the fifth, is made up of two portions of unequal size, the larger being derived from the Gasserian ganglion, and the smaller being the slender motor root of the fifth nerve. These two parts leave the skull by the foramen ovale in the sphenoid bone, and unite immediately after their exit. Two or three lines below the base of the skull, and under cover of the external pterygoid muscle, the nerve separates into two primary divisions, one of which is higher in position and smaller than the other.

The *small, anterior*, or *upper* portion receives the greater part of the fibres of the motor root, and breaks up into temporal, masseteric, external pterygoid, and buccal branches, of which the last alone is a sensory nerve. The *large, posterior*, or *lower* portion is chiefly sensory, and divides into auriculo-temporal, lingual or gustatory, and inferior dental nerves; it likewise supplies through the last-mentioned branch the mylo-hyoid muscle and the anterior belly of the digastric. The branch to the internal pterygoid muscle, with which also are connected those proceeding from the otic ganglion to the tensors of the palate and tympanum, is sometimes counted as a part of the larger division, but is more correctly regarded as arising from the undivided trunk.

The short trunk of the nerve also gives off, as it issues from the foramen ovale, a slender *recurrent* branch (Arnold), which passes backwards into the skull through the foramen spinosum with the middle meningeal artery, and divides like that vessel into two branches. The anterior of these sends its filaments into the great wing of the sphenoid bone, while the posterior traverses the petro-squamous fissure and is distributed to the mucous lining of the mastoid cells (Luschka).

The **deep temporal nerves** (figs. 316 and 322) are usually three in number, but are subject to considerable variety in their arrangement. The *anterior* is given off by the buccal nerve after it has perforated the external pterygoid, and ascends to supply the foremost part of the temporal muscle. The *middle* passes outwards above the external pterygoid and turns upwards close to the bone to enter the deep surface of the muscle. The *posterior* is generally conjoined with the masseteric nerve, and, taking a course similar to the middle branch, ramifies in the hinder part of the muscle. The number of these nerves is frequently reduced by the union of the middle with either of the other branches.

The **masseteric nerve** likewise passes above the external pterygoid,

Fig. 322.

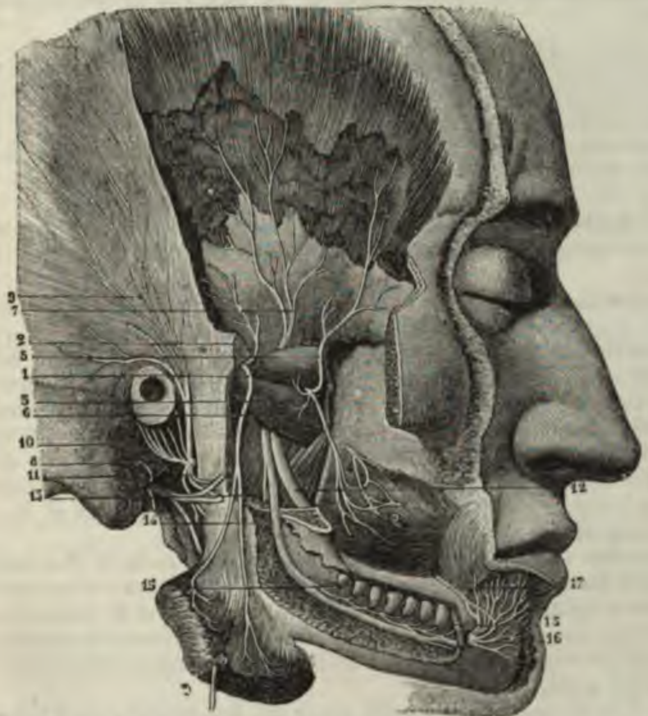


Fig. 322.—View of the branches of the inferior maxillary nerve from the outer side (from Sappey, after Hirschfeld and Leveillé). $\frac{2}{3}$

The zygoma and part of the ramus of the jaw have been removed; the dental canal has been opened up; the lower part of the temporal muscle has been taken away, and the masseter muscle turned down: 1, masseteric nerve; 2, posterior deep temporal nerve; 3, buccal nerve; 4, branch of the facial; 5, anterior deep temporal nerve; 6, filaments given by the buccal to the external pterygoid muscle; 7, middle deep temporal nerve; 8, auriculo-temporal nerve; 9, its temporal branches; 10, its branches to the meatus and auricle; 11, its union with the facial; 12, lingual nerve; 13, mylo-hyoid nerve; 14, inferior dental nerve; 15, its twigs to the teeth; 16, mental branch; 17, branch of the facial uniting with the mental.

and is directed nearly horizontally outwards at the posterior border of the temporal muscle, and through the sigmoid notch of the lower jaw, to the masseter, which it enters at the hinder part of its deep surface. It also gives a filament or two to the articulation of the jaw.

The **external pterygoid nerve** generally arises in common with the buccal branch, and penetrates the inner surface of its muscle.

The **buccal nerve**, which differs from the foregoing branches in being entirely a sensory nerve, is usually conjoined at its origin with the anterior deep temporal and the external pterygoid nerves. It passes forwards between the heads of the external pterygoid, and then descends in close contact with the inner side (occasionally perforating some of the fibres) of the temporal muscle at its insertion, to the surface of the buccinator muscle. Here it divides into several branches which join in a plexus round the facial vein with the buccal branches of the facial nerve, and are finally distributed to the skin and mucous membrane of the cheek, extending as far forwards as the angle of the mouth.

**Varieties.**—The buccal nerve is occasionally replaced by a branch of the superior maxillary (p. 560). It has been seen by Turner arising from the inferior dental nerve in the dental canal, and issuing by a small foramen in the alveolar border of the lower jaw, close to the ramus. Gaillet describes it in one case as arising directly from the Gasserian ganglion, and passing from the cranium through a special aperture between the round and oval foramina.

The **internal pterygoid nerve** is closely connected at its origin with the otic ganglion, and descends to the inner or deep surface of its muscle.

**Auriculo-temporal nerve.**—The auriculo-temporal nerve takes its origin close to the foramen ovale, usually by two roots which surround the middle meningeal artery. It is directed at first backwards, beneath the external pterygoid muscle, to the inner side of the neck of the lower jaw; then changing its course, it turns upwards between the ear and the temporo-maxillary articulation, under cover of the upper end of the parotid gland; and finally, emerging from beneath the latter, it ascends over the base of the zygoma in company with the superficial temporal artery, behind which it is placed, to terminate on the side of the head as the superficial temporal nerve.

*Branches.*—(*a*) *Communicating branches.*—The roots of the auriculo-temporal nerve are joined, close to their origin, by slender filaments from the otic ganglion; and from the trunk of the nerve, as it turns upwards, one or two considerable branches are sent forwards round the commencement of the superficial temporal artery to the temporo-facial division of the facial nerve.

(*b*) The *articular branches* are one or two fine twigs to the hinder part of the temporo-maxillary articulation.

(*c*) The *nerves of the external auditory meatus* are two in number, upper and lower, and enter the canal between the osseous and cartilaginous parts of its wall. They supply the skin of the meatus, and the upper one sends a filament to the membrana tympani.

(*d*) *Parotid branches* pass from the nerve, or from its connecting branches with the facial, to the gland.

(*e*) The *anterior auricular nerves* are usually two in number and supply the skin of the tragus and of the upper and fore part of the pinna.

(*f*) The *superficial temporal nerve* divides into slender branches which supply the skin over the greater part of the temporal region, the anterior ones forming communications with the temporal branches of the facial nerve (fig. 326, 18).

**Inferior dental nerve.**—The inferior dental is the largest of the three branches of the lower maxillary nerve. It descends under cover of the external pterygoid muscle, behind and to the outer side of the lingual nerve, and, passing between the ramus of the jaw and the internal lateral ligament of the temporo-maxillary articulation, enters the inferior dental canal. In company with the dental artery, it proceeds along this canal, and supplies branches to the teeth. At the mental foramen it bifurcates; one part, the incisor branch, being continued onwards within the bone towards the middle line, while the other, the much larger mental branch, escapes by the foramen to the face.

When about to enter the foramen on the inner surface of the ramus of the jaw, the inferior dental nerve gives off the slender mylo-hyoid branch.

(*a*) The *mylo-hyoid branch* descends in the groove on the inner side of the ramus of the lower jaw to the under surface of the mylo-hyoid muscle, to which and to the anterior belly of the digastric it is distributed. The fibres of this nerve may be traced back within the sheath of the inferior dental to the motor portion of the inferior maxillary nerve.

(*b*) The *dental branches* supply the molar and bicuspid teeth, together with the adjoining part of the gum. They form by their communications a fine *inferior dental plexus*, resembling that formed by the corresponding nerves in the upper jaw.

(*c*) The *incisor branch* continues the direction of the trunk of the nerve, and supplies filaments to the canine and incisor teeth.

(*d*) The *mental* or *labial nerve*, emerging from the bone by the mental foramen, divides beneath the depressor anguli oris into three parts, an inferior, which descends to the integument of the chin, and two superior, which ascend to the skin and mucous membrane of the lower lip. All three communicate freely with the supramaxillary branch of the facial nerve.

**Varieties.**—The inferior dental and lingual nerves have been observed to form a single trunk as far as the dental foramen. The inferior dental nerve sometimes has one or two accessory roots from other divisions of the inferior maxillary. The most common of these is one which arises from the Gasserian ganglion and remains separate until after it enters the dental canal (*lesser inferior dental nerve*, Sapolini).

The mylo-hyoid nerve frequently (constantly, Sappey) gives off a small branch, which pierces the mylo-hyoid muscle and joins the lingual nerve. Branches are also described as passing from the mylo-hyoid nerve to the depressor anguli oris and platysma myoides muscles (Henle), to the integument below the chin (Krause, Schwalbe), and to the submaxillary gland (Meckel, Henle, Curnow).

**Lingual nerve.**—The lingual branch (or gustatory nerve) descends under cover of the external pterygoid muscle, lying to the inner side and in front of the dental nerve, and generally united to that by a cord which may cross over the internal maxillary artery. Near its origin, it is joined at an acute angle by the *chorda tympani*, a small branch which is given off by the facial nerve, and descends from the inner end of the Glaserian fissure. It then passes between the internal pterygoid muscle and the ramus of the lower jaw, and is inclined obliquely inwards to the side of the tongue, over the upper constrictor of the pharynx, (where this muscle is attached to the maxillary bone) and above the deep portion of the submaxillary gland. Lastly, the nerve crosses below Wharton's duct, and is continued along the side of the tongue to the apex, lying immediately beneath the mucous membrane.

*Branches.*—(*a*) *Communicating branches.*—In addition to the cord above mentioned passing from the inferior dental to the lingual nerve, and the connection with the facial nerve through the chorda tympani, the lingual nerve gives off branches to the submaxillary ganglion at the place where it is in contact with the submaxillary gland, and a little farther forwards one or two filaments descend over the fore part of the hyo-glossus muscle to join in loops with similar branches of the hypoglossal nerve.

(*b*) *Branches to the mucous membrane* of the mouth are given from the nerve at the side of the tongue, and supply also the gum. Some delicate filaments are likewise distributed to the sublingual gland.

(*c*) The *lingual* or terminal branches perforate the muscular structure of the tongue, and divide into filaments which are directed upwards to the mucous membrane of the anterior two-thirds of the organ, where they terminate mainly in the conical and fungiform papillæ.

## Submaxillary Ganglion.

The submaxillary or lingual ganglion (fig. 331, 7) is placed above the deep portion of the submaxillary gland, and is connected by anterior and posterior filaments with the lingual nerve, from which it thus appears to be suspended by a loop. It is somewhat larger than the ophthalmic ganglion, and triangular or fusiform in shape. Its hinder part receives branches from nerves which may be regarded as its roots, while from its fore and lower parts proceed the branches for distribution.

ROOTS OF THE GANGLION.—The posterior connecting branch from the lingual nerve, often broken up into two or three filaments, conveys to the ganglion fibres from the chorda tympani and the inferior maxillary nerve, and thus represents the *motor* and *sensory roots* of the ganglion. The *sympathetic root* is formed by slender twigs from the plexus on the facial artery.

BRANCHES.—Five or six small nerves descend from the ganglion to the submaxillary gland, and others run forwards to the mucous membrane of the mouth and Wharton's duct. The anterior branch of communication with the lingual nerve is probably composed of fibres which pass from the ganglion and are distributed with the offsets of that nerve. There is also occasionally a small branch or two passing to the hypoglossal nerve (Meckel, Bose).

A minute *sublingual ganglion* is described by Blandin and some other anatomists on the filaments passing from the lingual nerve to the sublingual gland (fig 331, 8).

## Otic Ganglion.

The otic ganglion, or ganglion of Arnold, of a reddish-grey colour, is oval in shape, flattened from within out, and measures about one-sixth of an inch in its longest (antero-posterior) diameter. It is situated immediately below the foramen ovale, on the deep surface of the inferior maxillary nerve, covering, and not unfrequently surrounding, the origin of the internal pterygoid branch. Its inner surface is close to the cartilaginous part of the Eustachian tube and the tensor palati muscle; behind it is the middle meningeal artery.

Roots.—The ganglion receives, through its connection with the nerve to the internal pterygoid, fibres from the inferior maxillary nerve, and these may be regarded as constituting its *motor* and *sensory roots* (*short root* of Arnold); the *sympathetic root* is a filament (or two) passing forwards from the plexus on the middle meningeal artery. The ganglion is also joined posteriorly by the *small superficial petrosal nerve* (*long root*, Arnold), which connects it with, and probably conveys to it fibres from, the facial and glosso-pharyngeal nerves (p. 577).

Branches.—(*a*) Two or more filaments pass backwards to the roots of the auriculo-temporal nerve, in which their fibres appear, from the result of physiological experiments on animals, to be conducted to the parotid gland.

Fig. 323.

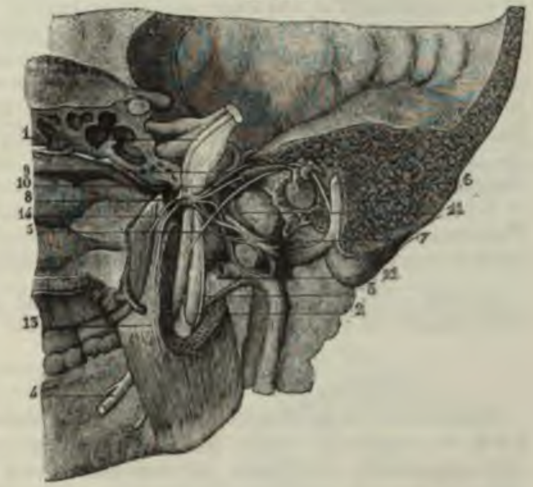


Fig. 323.—Otic ganglion and its connections from the inner side (from Sappey, after Arnold). $\frac{3}{2}$

The temporal bone is divided so as to show the inner surface of the membrana tympani and the canal of the facial nerve; the foramen ovale is opened on the inner side: 1, small root of the fifth nerve, passing down on the inner side of the Gasserian ganglion to unite with the inferior maxillary division; 2, inferior dental nerve 3, mylo-hyoid branch, seen also farther down emerging in front of the internal pterygoid muscle; 4, lingual; 5, chorda tympani; 6, facial nerve in its canal; 7, auriculo-temporal nerve, enclosing in its loop of origin the middle meningeal artery; 8, otic ganglion; 9, small superficial petrosal nerve; 10, branch to the tensor tympani muscle; 11, twig connecting the ganglion with the auriculo-temporal nerve; 12, twig to the ganglion from the sympathetic on the meningeal artery; 13, nerve to the internal pterygoid muscle; 14, branch to the tensor palati muscle.

(*b*) A communicating twig descends to the chorda tympani.

(*c* and *d*) Two small nerves are distributed to muscles—one to the tensor tympani, the other to the tensor palati, but the greater number of the fibres of these branches can be followed backwards to the inferior maxillary nerve, where they arise in common with the nerve to the internal pterygoid.

Summary.—Cutaneous filaments of the inferior maxillary nerve ramify on the side of the head, and the external ear, in the external auditory canal, the lower lip, and the lower part of the face; sensory branches are supplied by it to the greater part of the tongue; and branches are furnished to the mucous membrane of the mouth, the lower teeth and gums, the salivary glands, and the articulation of the lower jaw.

This nerve supplies the muscles of mastication, viz., the masseter, temporal, and two pterygoids; also the mylo-hyoid, the anterior belly of the digastric, the tensor palati and tensor tympani muscles.

### VI.—ABDUCENT NERVE.

The sixth nerve (abducent nerve of the eyeball, external oculomotor) makes its appearance as a flattened band in the groove between the pons and the medulla oblongata, immediately external to the upper end of the pyramid. One or two of the innermost bundles frequently issue between the fibres of the pyramid, or from the lower edge of the pons. The nerve speedily becomes rounded, and is directed forwards to an aperture in the dura mater at the lower and outer part of the dorsum sellæ. It then continues its course forwards, lying close to the floor of the cavernous sinus, in contact with the outer side of the internal carotid artery, and passes into the orbit through the sphenoidal fissure, and between the heads of the external rectus, to be distributed to that muscle, which it pierces on its ocular surface (fig. 315, 6; fig. 318, 5). As the nerve enters the orbit, it is placed below the other nerves passing through the sphenoidal fissure, but above the ophthalmic veins.

While contained in the cavernous sinus, the sixth nerve is joined by filaments from the carotid plexus of the sympathetic, and as it enters the orbit it receives a small filament from the ophthalmic nerve (Rosenthal).

**Variety.**—Absence of the sixth nerve upon one side is recorded, its place being supplied by a branch of the third nerve (Generali).

### VII.—FACIAL NERVE.

The seventh or facial nerve (portio dura of the seventh pair of Willis) takes its superficial origin from the uppermost part of the medulla oblongata, in the depression between the olivary and restiform bodies, where it emerges in a line with the roots of the fifth nerve, and close to the lower edge of the pons, to which it is frequently adherent for a short distance. To its outer side is the auditory nerve, and between the two is a slender fasciculus (fig. 310, between VII and VIII), which is known as the *portio* or *pars intermedia of Wrisberg*, and joins the facial nerve in the auditory canal. This intermediate part is frequently connected more or less closely at its origin with one or both of the nerves between which it lies, and in many cases a few of its fibres pass distally into the auditory nerve (E. Bischoff, Henle).

From its origin, the facial nerve is directed outwards in company with the auditory nerve to the internal auditory meatus. Here the facial lies in a groove along the upper and fore part of the auditory nerve, and the portio intermedia is placed between the two. At the bottom of the meatus the facial nerve enters the aqueduct of Fallopius, and follows the windings of that canal through the temporal bone to the lower surface of the skull. It passes at first horizontally outwards for a short distance, between the cochlea and vestibule, to the inner wall of the tympanum, where it bends sharply backwards above the fenestra ovalis, and then arches downwards behind the pyramid and the tympanic cavity to issue by the stylo-mastoid foramen. At the place where it turns backwards (genu), the nerve presents on its fore part a reddish enlargement which contains numerous nerve-cells, and is named the *geniculate ganglion* (intumescentia ganglioformis). Below the skull, the trunk is continued downwards and forwards through the substance of the parotid gland, and a little behind the ramus of the lower jaw it terminates by dividing into two parts, *temporo-facial* and *cervico-facial*, from which numerous branches spread over the side of the head, the face, and the upper part of the neck, communicating freely with one another, and thus forming a radiating plexus to which the name of *pes anserinus* is given.

Fig. 324.

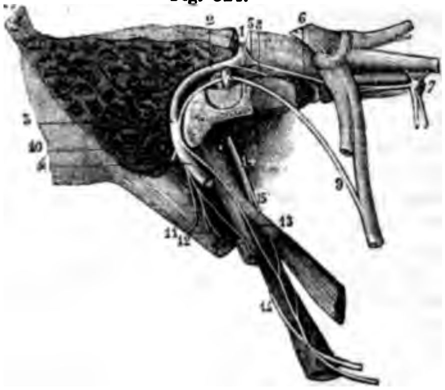


Fig. 324.—THE FACIAL NERVE IN ITS CANAL, WITH ITS CONNECTING BRANCHES, &c. (from Sappey, after Hirschfeld and Leveillé). ⅔

The mastoid and a part of the petrous bone have been divided nearly vertically, and the canal of the facial nerve opened in its whole extent from the internal meatus to the stylo-mastoid foramen; the Vidian canal has also been opened from the outside: 1, facial nerve in the first horizontal part of its course; 2, its second part turning backwards; 3, its vertical portion; 4, the nerve at its exit from the stylo-mastoid foramen; 5, geniculate ganglion; 6, large superficial petrosal nerve; 7, spheno-palatine ganglion; 8, small superficial petrosal nerve; 9, chorda tympani; 10, posterior auricular branch cut short; 11, branch to the digastric muscle; 12, branch to the stylo-hyoid muscle; 13, twig uniting with the glosso-pharyngeal nerve (14 and 15).

Fig. 325.

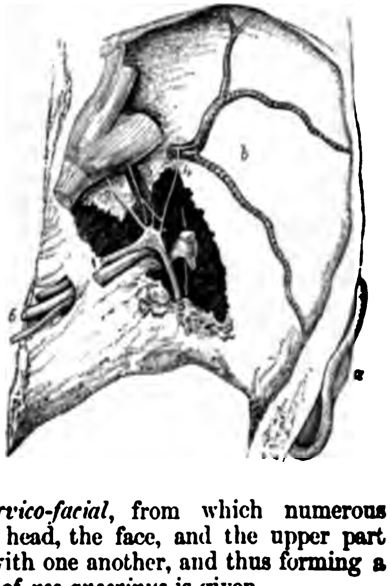


Fig. 325.—GENICULATE GANGLION OF THE FACIAL NERVE AND ITS CONNECTIONS FROM ABOVE (from Bidder).

The dissection is made in the middle fossa of the skull on the right side; part of the temporal bone being removed so as to open the internal auditory meatus, hiatus Fallopii, and a part of the canal of the facial nerve, together with the cavity of the tympanum: *a*, auricle; *b*, middle fossa of the skull with the meningeal artery ramifying in it; 1, facial and auditory nerves in the internal auditory meatus: 2, large superficial petrosal nerve; 3, small superficial petrosal nerve lying over the tensor tympani muscle; 4, external superficial petrosal nerve joining sympathetic twigs on the meningeal artery; 5, facial and chorda tympani; 6, nerves entering the jugular foramen.

BRANCHES.—A. *Arising from the facial nerve during its course through the temporal bone :—*

**Communicating filaments with the auditory nerve.**—These are one or two slender twigs passing between the geniculate ganglion and the upper division of the eighth nerve at the bottom of the internal auditory meatus.

The **large superficial petrosal nerve** is directed forwards from the geniculate ganglion, and issues by the hiatus Fallopii on the upper surface of the petrous portion of the temporal bone. Inclining downwards beneath the Gasserian ganglion, the nerve enters the foramen lacerum, and is continued across the outer side of the internal carotid artery to the posterior opening of the Vidian canal, where it unites with the large deep petrosal nerve (derived from the sympathetic on the carotid artery) to form the Vidian nerve joining the back of the spheno-palatine ganglion (p. 563).

**Communication with the small superficial petrosal nerve.**—A minute branch connects the geniculate ganglion with the small superficial petrosal nerve passing from the tympanic plexus to the otic ganglion (p. 577).

The **external superficial petrosal nerve** (Bidder) unites the geniculate ganglion with the sympathetic filaments on the middle meningeal artery. This nerve is not always present (Rauber).

A **branch to the stapedius muscle** is given off by the facial nerve as it descends behind the pyramid.

**Chorda tympani.**—The branch named chorda tympani arises from the facial nerve at the lower end of the aqueduct of Fallopius, and is directed upwards and forwards through a small canal which opens on the posterior wall of the tympanum, close to the attachment of the tympanic membrane. It then arches forwards, being invested by the mucous lining of the cavity, across the upper part of the membrane and over the inner side of the handle of the malleus, above the insertion of the tensor tympani muscle. Finally, leaving the cavity by an aperture at the inner end of the Glaserian fissure, the nerve inclines downwards on the mesial side of the internal lateral ligament of the jaw, and unites at an acute angle with the lingual nerve, in which its fibres are continued to the submaxillary ganglion and the tongue. Before joining the lingual nerve, the chorda receives a communicating filament from the otic ganglion.

A **communication with the auricular branch of the pneumogastric nerve** is generally present, in the form of a twig leaving the facial nerve close above the stylo-mastoid foramen (see p. 582).

B. *Arising from the facial nerve below the base of the skull :—*

The **posterior auricular nerve** arises close to the stylo-mastoid foramen, and turns upwards between the ear and the mastoid process, where it divides into auricular and occipital branches.

The *auricular branch* ascends behind the ear and is distributed to the retrahens auriculam and the small muscles on the cranial surface of the pinna. A twig is sometimes continued upwards to the hinder part of the attollens muscle.

The *occipital branch* is directed backwards close to the bone, and supplies the posterior part of the occipito-frontalis muscle.

The posterior auricular nerve receives communications from the great auricular and small occipital nerves of the cervical plexus, as well as from the auricular branch of the pneumo-gastric, and certain filaments which may sometimes be followed from its branches to the skin are probably composed of fibres derived from these nerves.

The **digastric branch** arises close below the preceding nerve, and divides into two or three filaments which enter the posterior belly of the digastric muscle ; one of these sometimes passes through or above the digastric, and joins the glosso-pharyngeal nerve near the base of the skull.

The **stylo-hyoid branch**, long and slender, arises in common with the digastric branch, and inclines forwards to enter the stylo-hyoid muscle on its posterior aspect.

TEMPORO-FACIAL DIVISION.—The temporo-facial, the larger of the two primary divisions of the facial nerve, is directed forwards through the upper part of the parotid gland, crossing over the external carotid artery and the temporo-maxillary vein. It receives one or two considerable offsets from the auriculo-temporal nerve (p. 566), and speedily divides into a number of branches which form, by their communications with one another and with branches of the fifth nerve, a network over the side of the face, extending as high as the temple and as low as the mouth. Its ramifications are arranged in temporal, malar, and infraorbital sets.

The **temporal branches** ascend over the zygoma and supply the attrahens and attollens auriculam muscles, the frontalis, the upper part of the orbicularis palpebrarum, and the corrugator supercilii. One or two filaments pass on to the auricle, and are distributed to the small muscles on its outer surface. These branches form communications with the auriculo-temporal nerve, the temporal branch of the superior maxillary, and the supraorbital and lachrymal branches of the ophthalmic nerve.

The **malar branches** cross the malar bone to reach the outer side of the orbit and supply the orbicular muscle. Some filaments are distributed to both the upper and lower eyelids : those in the upper lid join filaments from the lachrymal and supraorbital nerves, and those in the lower lid are connected with filaments from the superior maxillary nerve. Filaments from this part of the facial also communicate with the malar branch of the upper maxillary nerve.

The **infraorbital branches**, of larger size than the others, are almost horizontal in direction, and are distributed between the orbit and mouth. They supply the buccinator and orbicularis oris muscles, the elevators of the upper lip and angle of the mouth, and the muscles of the nose. Beneath the elevator of the upper lip these nerves are united in a plexus with the terminal branches of the superior maxillary nerve ; on the side of the nose they communicate with the nasal, and at the inner angle of the orbit with the infratrochlear nerve. The lower branches of this set are connected with those of the cervico-facial division.

CERVICO-FACIAL DIVISION.—This division of the facial nerve is directed obliquely through the parotid gland towards the angle of the lower jaw, and gives branches to the face, below those of the preceding division, and to the upper part of the neck. The branches are named buccal, supramaxillary, and inframaxillary. In the gland, this division of the facial nerve is joined by filaments of the great auricular nerve of the cervical plexus, and offsets from it penetrate the substance of the gland.

The **buccal branches** are directed across the masseter muscle to the angle of the mouth ; supplying the buccinator and sphincter muscles, they communicate with the temporo-facial division, and on the buccinator muscle join with filaments of the buccal branch of the inferior maxillary nerve.

The **supramaxillary branch**, sometimes double, runs forwards beneath the depressor anguli oris, and, after communicating with the mental branch of the inferior dental nerve, supplies the muscles of the lower lip. One superficial branch is continued along the margin of the lower jaw to the chin.

Fig. 326.

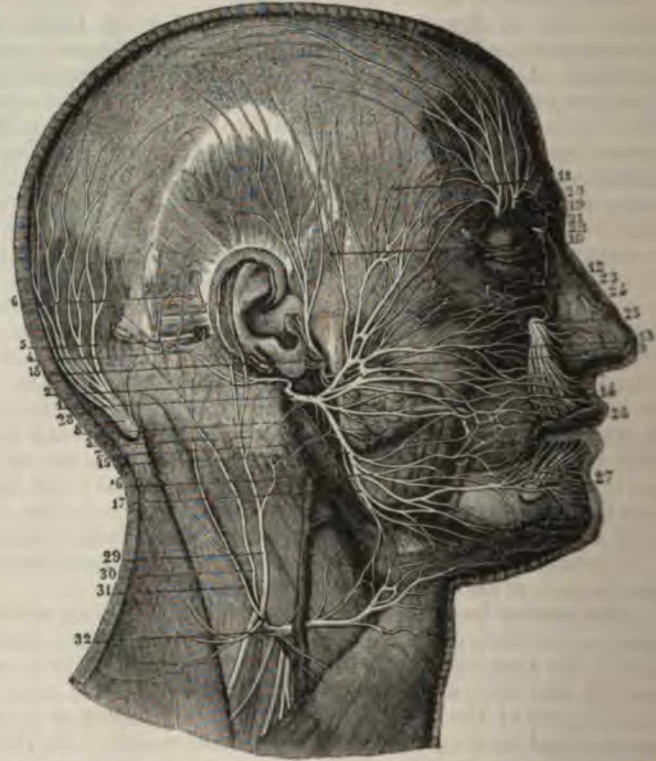


Fig. 326.—SUPERFICIAL DISTRIBUTION OF THE FACIAL, TRIGIMENAL AND OTHER NERVES OF THE HEAD (from Sappey, after Hirschfeld and Leveillé).

*a, Facial Nerve.*—1, trunk of the facial nerve after its exit from the stylo-mastoid foramen; 2, posterior auricular branch; 3, filament of the great auricular nerve uniting with the foregoing; 4, occipital branch; 5, auricular branch; 6, twig to the superior auricular muscle; 7, nerve to the digastric; 8, that to the stylo-hyoid muscle; 9, superior or temporo-facial division of the nerve; 10, 11, temporal branches; 12, malar; 13, 14, infra-orbital; 15, inferior or cervico-facial division of the nerve; 16, supramaxillary, and above this the buccal branches; 17, inframaxillary branch.

*b, Fifth Nerve.*—18, auriculo-temporal nerve uniting with the facial, giving anterior auricular and parotid branches, and ascending to the temporal region; 19, 20, supra-orbital nerve; 21, palpebral twigs of the lachrymal; 22, infratrochlear nerve; 23, malar twig of the orbito-malar; 24, superficial branch of the nasal nerve; 25, infraorbital nerve; 26, buccal nerve uniting with branches of the facial; 27, mental nerve.

*c, Cervical Nerves.*—28, great occipital nerve; 29, great auricular nerve; 30, 31, small occipital; 32, superficial cervical nerve.

The **inframaxillary branch** perforates the deep cervical fascia and divides into slender offsets, which form arches beneath the platysma as low as the hyoid bone. Some branches join the superficial cervical nerve beneath the platysma, others enter that muscle, and a few perforate it to end in the integument.

SUMMARY.—The facial nerve is the principal motor nerve of the head, supplying all the superficial, and several of the deep muscles. Its superficial offsets are distributed to the muscles of the scalp, the muscles of the external ear, nose, mouth, and eyelids (with the exception of the levator palpebræ superioris), and to the cutaneous muscle of the neck (platysma). It likewise supplies the muscles of the tympanum, the levator palati and azygos uvulæ muscles (through the large superficial petrosal nerve), and in the neck the stylo-hyoid and the posterior belly of the digastric.

The facial nerve is freely connected with the three divisions of the fifth nerve ; and it also has communications with the spheno-maxillary, submaxillary and otic ganglia, with the auditory, glosso-pharyngeal and pneumo-gastric nerves (through the auricular branch of the latter), and with parts of the sympathetic and spinal nerves.

## VIII.—AUDITORY NERVE.

The eighth or auditory nerve (portio mollis of the seventh pair of Willis) makes its appearance on the outer side of the facial nerve, and is closely adherent for a short distance to the lower border of the pons (or middle peduncle of the cerebellum). It commences by two roots, the one of which (the *inferior*) arises in part superficially from the floor of the fourth ventricle, and in part issues from the inner side of the restiform body, while the other (the *superior*) emerges slightly higher up from the front of the restiform body.

The two roots unite as they leave the medulla oblongata, and the nerve is directed outwards to the internal auditory meatus, in company with the facial nerve, which rests in a groove along its upper and fore part, and the auditory artery, which, together with the portio intermedia of the facial nerve, is placed between the two trunks. In the meatus, the nerve divides into an upper smaller and a lower larger part ; the *upper* division furnishes branches to the utricle and the ampullæ of the superior and external semicircular canals, while the *lower* is mainly distributed to the cochlea, but also sends offsets to the saccule and the posterior semicircular canal. (See the anatomy of the ear in Vol. II.)

The auditory nerve often receives some of the fibres of the portio intermedia, and its upper division is connected at the bottom of the internal auditory meatus with the geniculate ganglion of the facial nerve.

## IX.—GLOSSO-PHARYNGEAL NERVE.

The ninth or glosso-pharyngeal nerve (first trunk of the eighth pair of Willis) arises from the upper part of the medulla oblongata, in the groove between the olivary and restiform bodies, by five or six filaments arranged in a vertical line commencing immediately below the facial and auditory nerves.

From its origin, the glosso-pharyngeal nerve is directed outwards in front of the flocculus to the middle compartment of the jugular foramen, through which it passes in company with the pneumo-gastric and spinal accessory nerves, but in a separate tube of dura mater. In the foramen, where it is placed external to and somewhat in front of the other nerves, it is lodged in a groove, occasionally a canal, in the lower border of the petrous portion of the temporal bone, and it presents, successively, two ganglionic enlargements :—the jugular ganglion and the petrous ganglion.

After leaving the skull, the glosso-pharyngeal nerve appears between the internal carotid artery and the jugular vein, and is directed downwards over the carotid artery and beneath the styloid process and the muscles connected with it, to the hinder border of the stylo-pharyngeus; then curving gradually forwards, it crosses over the outer surface of the latter muscle, and passes beneath the hyo-glossus to end in branches for the hinder part of the tongue (fig. 329, 16).

Fig. 327.

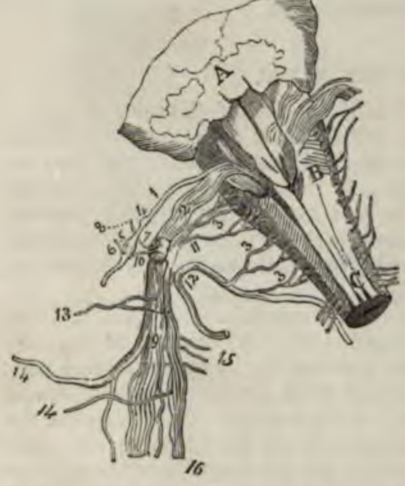


Fig. 327.—Diagrammatic sketch from behind of the roots of the ninth, tenth, and eleventh nerves, with their ganglia and communications (from Bendz).

A, part of the cerebellum above the fourth ventricle; B, medulla oblongata; C, spinal cord; 1, glosso-pharyngeal nerve; 2, pneumo-gastric; 3, 3, 3, spinal accessory; 4, jugular ganglion of the glosso-pharyngeal; 5, petrous ganglion; 6, tympanic branch; 7, ganglion of the root of the pneumo-gastric; 8, auricular branch; 9, ganglion of the trunk of the pneumo-gastric; 10, branch from the upper ganglion to the petrous ganglion of the glosso-pharyngeal; 11, inner portion of the spinal accessory; 12, outer portion; 13, pharyngeal branch of the pneumo-gastric; 14, 14, superior laryngeal branch; 15, twigs connected with the sympathetic; 16, external part of the spinal accessory prolonged with the pneumo-gastric.

The **jugular ganglion** is situated at the upper part of the osseous groove in which the nerve lies during its passage through the jugular foramen. It is from half a line to a line in length, and it includes only the lower filaments of the nerve, the upper ones forming a separate fasciculus which passes over the ganglion, and joins the trunk of the nerve below it. This ganglion is not always to be distinguished, and it is regarded by Henle and others as resulting, when present, from the more or less complete separation of a part of the petrous ganglion.

The **petrous ganglion** is contained in a small depression at the lower end of the groove in the petrous part of the temporal bone, and measures from two to three lines in length. From it arise the small branches by which the glosso-pharyngeal is connected with other nerves at the base of the skull; these are the tympanic nerve, and the branches of communication with the pneumo-gastric and sympathetic.

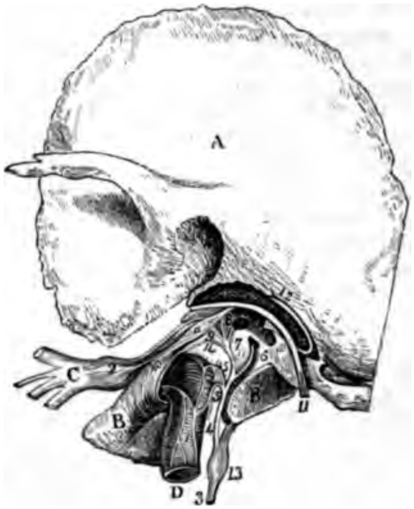
Branches.—A. *Connecting branches and tympanic branch.*

One filament unites the petrous ganglion of the glosso-pharyngeal nerve with the upper cervical ganglion of the sympathetic; a second passes to the auricular branch of the pneumo-gastric; and a third, which however is not constant, joins the ganglion of the root of the pneumo-gastric nerve.

Fig. 328.—The tympanic branch of the glosso-pharyngeal nerve, and its connections (from Breschet).

A, squamous part of the left temporal bone; B, petrous part; C, inferior maxillary nerve; D, internal carotid artery; *a*, tensor tympani muscle; 1, sympathetic plexus; 2, otic ganglion; 3, glosso-pharyngeal nerve; 4, tympanic nerve; 5, 5, twigs joining the sympathetic; 6, twig to fenestra rotunda; 7, twig to fenestra ovalis; 8, junction with the facial nerve; 9, small superficial petrosal nerve; 10, twig from the otic ganglion to the tensor tympani muscle; 11, facial nerve; 12, chorda tympani; 13, petrous ganglion of the glosso-pharyngeal; 14, small deep petrosal nerve.

Fig. 328.



The glosso-pharyngeal nerve is also joined below the petrous ganglion, in many cases, by a communicating branch from the facial nerve (p. 573).

The **tympanic branch** (nerve of Jacobson) ascends from the petrous ganglion through a small canal, the orifice of which is seen on the ridge of bone between the jugular fossa and the carotid foramen. Having gained the inner wall of the tympanum, the nerve runs upwards and forwards in a groove on the surface of the promontory, and, after giving (or receiving) several branches, leaves the cavity at its upper and fore part, where it becomes the *small superficial petrosal nerve.* The latter traverses a small canal, which crosses beneath the upper end of the canal of the tensor tympani muscle, and emerges on the upper surface of the petrous portion of the temporal bone, immediately external to the hiatus Fallopii. Then inclining downwards, the nerve passes from the skull through the fissure between the petrous and the great wing of the sphenoid, or occasionally through a small aperture in the latter bone, and terminates in the otic ganglion. As it lies in its canal, the small superficial petrosal nerve is joined by a filament of communication from the geniculate ganglion of the facial nerve, or from the large superficial petrosal nerve close to that ganglion.

The branches of the tympanic nerve are partly distributed to the mucous lining of the middle ear, and partly form communications with other nerves, giving rise to what is called the *tympanic plexus.* Of the former set, the principal branches are, one directed forwards to the Eustachian tube, and two backwards to the neighbourhood of the fenestra rotunda and fenestra ovalis, and to the mastoid cells. The communicating branches are, in addition to the small superficial petrosal furnished successively to the pharynx, the larynx, and the heart; in the thorax, additional branches are supplied to the heart, as well as offsets to the lungs and œsophagus; and in the abdomen, its terminal branches are distributed to the stomach, liver, and other organs.

A. *Branches of communication.*

The **upper ganglion** of the pneumo-gastric nerve receives a twig from the superior cervical ganglion of the sympathetic; one or two filaments pass between it and the spinal accessory nerve; and there is sometimes a filament connecting it with the petrous ganglion of the glosso-pharyngeal.

The **lower ganglion** of the pneumo-gastric forms connections with the hypoglossal nerve, with the superior cervical ganglion of the sympathetic, and with the loop between the first two cervical nerves.

B. *Branches of distribution.*

The **recurrent** or **meningeal branch** arises from the upper ganglion of the pneumo-gastric, and passes backwards through the jugular foramen to be distributed to the dura mater in the posterior fossa of the base of the skull.

The **auricular branch** (nerve of Arnold) is given off from the ganglion of the root, and, after receiving a filament from the petrous ganglion of the glosso-pharyngeal nerve, runs backwards along the outer boundary of the jugular foramen to an opening near the root of the styloid process. It then traverses the substance of the temporal bone, crosses the aqueduct of Fallopius on its inner side about two lines from the lower end, forming here a communication with the facial nerve, and finally emerges between the external auditory meatus and the mastoid process, where it divides into two parts, the one of which joins the posterior auricular nerve, while the other is distributed to the skin of the back of the pinna, and the lower and back part of the auditory canal.

**Varieties.**—In rare instances, absence of the auricular branch has been observed, or of the communication with the facial nerve. The auricular branch occasionally passes entirely into the facial trunk, and in that case its fibres are probably conveyed to the external ear through the posterior auricular nerve.

The **pharyngeal branch**, often represented by two or even more offsets, and composed mainly of fibres prolonged from the accessory part of the spinal accessory nerve, leaves the upper part of the ganglion of the trunk of the vagus. It courses inwards over the internal carotid artery, and divides into branches which, conjointly with those derived from the glosso-pharyngeal and the sympathetic, form the *pharyngeal plexus*. This plexus often contains one or more small ganglia, and from it filaments pass to the muscles and mucous membrane of the larynx. One slender branch (*lingual branch of the vagus*—Luschka) descends from the pharyngeal plexus, receiving its fibres from the pharyngeal branches of both the glosso-pharyngeal and pneumo-gastric nerves, and joins the hypoglossal nerve as that turns round the occipital artery.

**Superior laryngeal nerve.**—This branch springs from the middle of the ganglion of the trunk of the vagus, and inclines forwards on the inner side of the internal carotid artery towards the larynx. It is joined by fine filaments from the upper cervical ganglion of the sympathetic and from the pharyngeal plexus, and speedily divides into two branches which are distinguished as external and internal laryngeal.

The *external laryngeal branch*, the smaller of the two, runs downwards and forwards beneath the depressor muscles of the hyoid bone to the crico-thyroid muscle in which it ends. It receives a filament from the upper cervical ganglion of the sympathetic, and it gives off twigs to the inferior constrictor muscle of the pharynx, as well as generally a cardiac branch which joins the superior cardiac branch of the sympathetic.

Offsets of the external laryngeal nerve have been described by different anatomists as passing to the pharyngeal plexus, to the thyroid body, to the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles, and to the mucous membrane of the true vocal cord.

The *internal laryngeal branch* is continued to the interval between the hyoid bone and the thyroid cartilage, where it perforates the thyro-hyoid membrane with the laryngeal branch of the superior thyroid artery, and breaks up into numerous diverging branches which supply the mucous membrane of the greater part of the larynx. Some of these ascend in the aryteno-epiglottidean fold to the base of the tongue and the epiglottis; while others pass downwards to the false vocal cord, and also to the part of the pharyngeal mucous membrane covering the back of the larynx. One long branch descends beneath the ala of the thyroid cartilage, and joins at the lower part of the larynx a similar offset ascending from the recurrent laryngeal nerve.

**Inferior laryngeal nerve.**—The inferior or recurrent laryngeal nerve of the right side arises at the root of the neck, and turns backwards below the subclavian artery; the nerve of the left side arises in the upper part of the thorax, and is reflected round the transverse part of the arch of the aorta immediately beyond the attachment of the ligament of the ductus arteriosus. Each nerve ascends in the neck, passing behind the common carotid and inferior thyroid arteries, and lying in the groove between the trachea and œsophagus, to the lower border of the cricoid cartilage, where it enters the larynx beneath the inferior constrictor muscle. Under cover of the ala of the thyroid cartilage, the nerve divides into branches which supply all the intrinsic muscles of the larynx, with the exception of the crico-thyroid. It likewise gives a few offsets to the mucous membrane below the rima glottidis, and a connecting filament which joins the long branch of the upper laryngeal nerve beneath the hinder part of the thyroid cartilage.

The recurrent nerve also furnishes branches to the cardiac plexus, and twigs of communication with the inferior cervical ganglion of the sympathetic, as it turns round the large artery; tracheal and œsophageal branches as it ascends in the neck; and lastly, offsets to the inferior constrictor of the pharynx as it passes beneath that muscle.

**Cardiac branches.**—Branches to the heart are given off by the pneumo-gastric nerve both in the neck and in the thorax.

The *cervical cardiac* branches arise at both the upper and the lower part of the neck. The *upper branches*, one or two, are small, and join the cardiac nerves of the sympathetic. The *lower*, a single branch, arises as the pneumo-gastric nerve is about to enter the chest. On the right side this branch lies by the side of the innominate artery, and joins one of the cardiac nerves destined for the deep cardiac plexus; it gives some filaments to the coats of the aorta. The branch of the left side crosses the arch of the aorta, and ends in the superficial cardiac plexus.

The *thoracic cardiac* branches of the right side leave the trunk of the

Fig. 331.

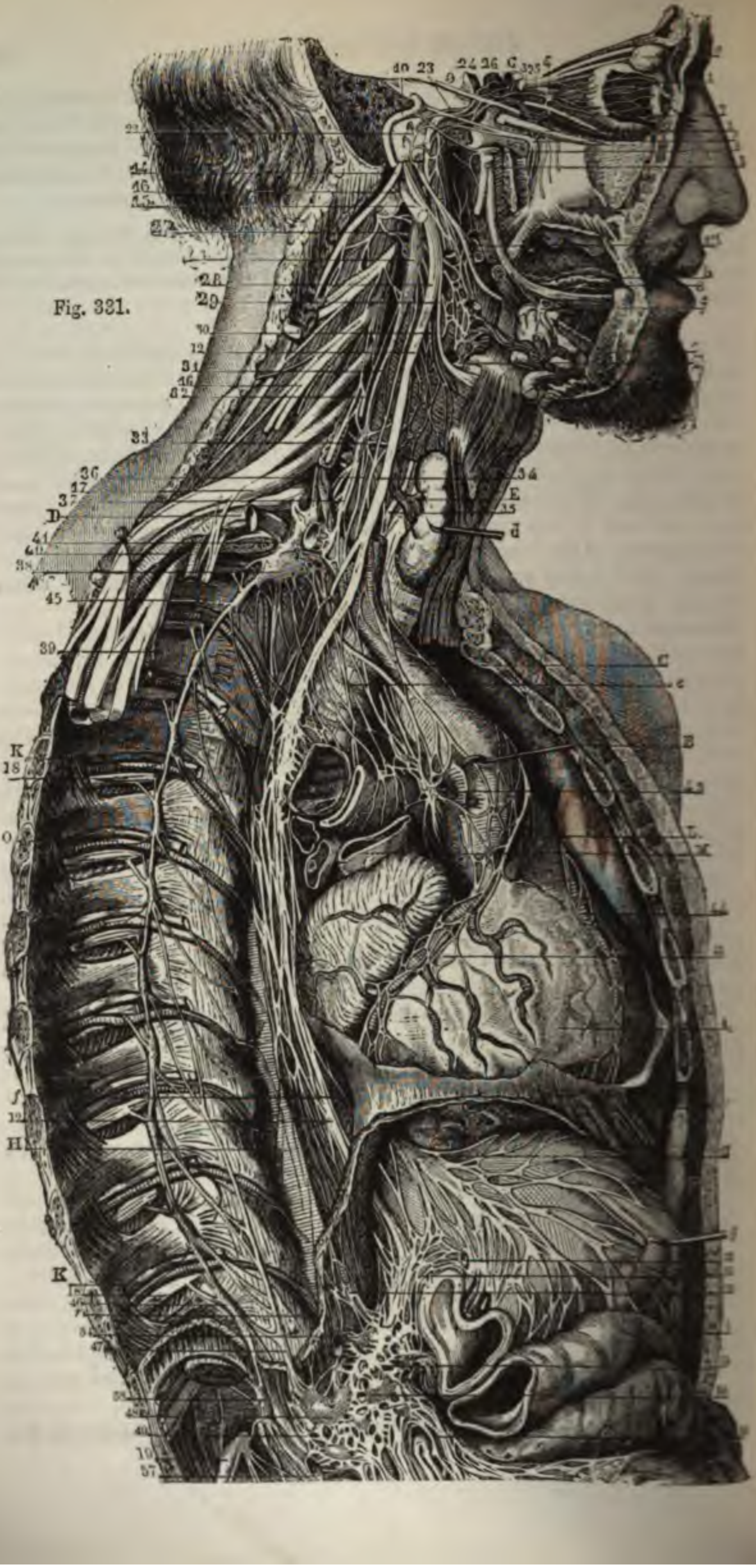

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Fig. 331.—View of the distribution and connections of the pneumo-gastric and sympathetic nerves on the right side (after Hirschfeld and Leveillé). ⅓

*a*, lachrymal gland ; *b*, sublingual gland ; *c*, submaxillary gland and facial artery ; *d*, thyroid body ; *e*, trachea, below which is the right bronchus cut across ; *f*, œsophagus ; *g*, stomach, divided near the pylorus ; *i*, transverse colon ; *r*, the diaphragm.

A, heart ; B, aortic arch, drawn forwards to show the cardiac plexus ; C, innominate artery ; D, subclavian artery ; E, inferior thyroid artery ; F, a divided part of the external carotid artery, upon which runs a nervous plexus ; G, internal carotid emerging from its canal superiorly ; H, descending thoracic aorta ; K, intercostal vein ; L, pulmonary artery ; M, superior vena cava ; O, intercostal artery.

1, ciliary nerves ; 2, branch of the third nerve to the inferior oblique muscle ; 3, 3, 3, the three divisions of the fifth nerve ; 4, ophthalmic ganglion ; 5, spheno-palatine ; 6, otic ; 7, submaxillary ; 8, sublingual ; 9, sixth nerve ; 10, facial in its canal, uniting with the spheno-palatine and otic ganglia ; 11, glosso-pharyngeal ; 12, right pneumo-gastric ; 13, left pneumo-gastric spreading on the anterior surface of the stomach ; 14, spinal accessory ; 15, hypoglossal ; 16, 16, nerves of the cervical plexus ; 17, middle nerve of the brachial plexus ; 18, intercostal nerves ; 19, lumbar nerve ; 21, superior cervical ganglion connected with 22, the tympanic nerve ; 23, large superficial petrosal nerve ; 24, cavernous plexus ; 25, sympathetic root of the ophthalmic ganglion ; 26, filament to the pituitary body ; 27, union of the sympathetic with the upper cervical nerves ; 28, pneumo-gastric nerve ; 29, superior laryngeal nerve ; 30, pharyngeal plexus ; 31, cord of the sympathetic nerve ; 32, superior cardiac nerve ; 33, middle cervical ganglion ; 34, twig connecting the ganglion with, 35, the recurrent ; 36, middle cardiac nerve ; 37, cord of the sympathetic ; 38, inferior cervical ganglion ; 39, the line from this number crosses the nerves proceeding from the brachial plexus ; 40, sympathetic twigs surrounding the axillary artery ; 41, branch of union with the first intercostal nerve ; the line from the letter *e*, pointing to the trachea, crosses the superior, middle, and inferior cardiac nerves ; 42, cardiac plexus ; 43, 44, right and left coronary plexuses ; 45, 46, thoracic portion of the sympathetic cord ; 47, great splanchnic nerve ; 48, semilunar ganglion ; 49, lesser splanchnic ; 50, solar plexus ; 51, union with the pneumo-gastric nerve ; 52, diaphragmatic plexus ; 53, coronary plexus ; 54, hepatic ; 55, splenic ; 56, superior mesenteric ; 57, renal plexus ; 58, first lumbar sympathetic ganglion.

pneumo-gastric as this nerve lies by the side of the trachea, and some are also derived from the first part of the recurrent branch ; they pass inwards on the air-tube, and end in the deep cardiac plexus. The corresponding branches of the left side usually come entirely from the recurrent laryngeal nerve.

**Pulmonary branches.**—Two sets of pulmonary branches are distributed from the pneumo-gastric nerve to the lung ; and they reach the root of the lung, one on its fore part, the other on its posterior aspect. The *anterior* pulmonary nerves, two or three in number, are of small size. They join with filaments of the sympathetic ramifying on the pulmonary artery, and with these nerves constitute the *anterior pulmonary plexus.* Behind the root of the lung the pneumo-gastric nerve becomes flattened, and gives several branches of much larger size than the anterior branches, which, with filaments derived from the second, third, and fourth thoracic ganglia of the sympathetic, form the *posterior pulmonary plexus.* Offsets from this plexus extend along the ramifications of the air-tube through the substance of the lung.

The anterior and posterior pulmonary plexuses of the two sides communicate with one another in an open network across the front and back respectively of the lower end of the trachea, and through these networks fibres are conveyed from each pneumo-gastric nerve into both lungs.

**Œsophageal branches.**—The œsophagus within the thorax receives branches from the pneumo-gastric nerves, both above and below the pulmonary branches. The lower branches are the larger, and are derived from the *œsophageal plexus,* formed by connecting cords between the nerves of the right and left sides, while they lie in contact with the œsophagus.

**Gastric branches.**—The branches distributed to the stomach (*gastric nerves*) are the terminal branches of both pneumo-gastric nerves. The nerve of the left side, on arriving in front of the œsophagus, opposite the cardiac orifice of the stomach, divides into many branches: the largest of these extend over the fore part of the stomach; others lie along its small curvature, and unite with branches of the right nerve and the sympathetic; and some filaments are continued between the layers of the small omentum to the hepatic plexus. The right pneumo-gastric nerve descends on the back of the gullet to the stomach, and distributes branches to the posterior surface of the organ: a large portion of this nerve passes to the cœliac, splenic and left renal plexuses of the sympathetic.

SUMMARY.—The pneumo-gastric nerves supply branches directly to the upper part of the alimentary canal, viz., the pharynx, œsophagus, and stomach with the liver and spleen; and to the respiratory passages, namely, the larynx, trachea, and its divisions in the lungs. They also furnish small offsets to the dura mater and external ear. These nerves give branches likewise to the heart and great vessels by means of their communications with the cardiac plexus, and to the remaining abdominal viscera through their connection with the solar plexus. Each pneumo-gastric nerve is connected with the following cranial nerves—the spinal accessory, glosso-pharyngeal, facial, and hypoglossal; also with some spinal nerves; and with the sympathetic in the neck, thorax and abdomen.

## XI.—SPINAL ACCESSORY NERVE.

The eleventh or spinal accessory nerve (spinal nerve accessory to the vagus, third trunk of the eighth pair of Willis) consists of two parts, the one of which (accessory) joins the trunk of the pneumo-gastric, while the other (spinal) is distributed to the sterno-mastoid and trapezius muscles. It arises by a series of filaments from the side of the medulla oblongata below the pneumo-gastric nerve, and from the lateral column of the spinal cord as low down as the sixth or seventh cervical nerve. The filaments arising from the medulla oblongata form the small accessory portion of the nerve. The lowest spinal filaments are attached to the middle of the lateral column; the highest ones arise close to the posterior nerve-roots, with the upper one or two of which they are frequently connected.

The accessory portion is directed outwards with the pneumo-gastric nerve: the spinal part ascends between the ligamentum denticulatum and the posterior roots of the cervical nerves, passes into the skull through the foramen magnum, and immediately bends outwards to enter the middle compartment of the jugular foramen, where the nerve is contained in the same sheath of dura mater as the vagus. In the foramen, the two parts of the nerve interchange fibres, and they are sometimes intimately united so as to form a single trunk for a short distance. The accessory part is also connected by one or two filaments with the ganglion of the root of the pneumo-gastric.

Below the skull, the *internal, accessory* or *vagal portion* passes over the surface of the lower ganglion of the vagus, and sends its fibres into the pharyngeal and superior laryngeal branches, and into the trunk of that nerve below the ganglion in the manner already described.

The *external* or *spinal portion* (fig. 332, 5), after issuing from the jugular foramen, is directed backwards across the front of the internal jugular vein, and perforates the sterno-mastoid muscle, supplying this with branches, and joining amongst the fleshy fibres with the nerve furnished to the muscle from the cervical plexus. Descending in the next place obliquely across the posterior triangular space of the neck behind the sterno-mastoid, the nerve passes beneath the trapezius muscle. Here it forms a kind of plexus with branches of the third and fourth cervical nerves, and distributes filaments to the trapezius, which extend nearly to the lower border of the muscle.

**Varieties.**—The external portion of the spinal accessory nerve frequently crosses behind the internal jugular vein. It is also found sometimes passing beneath the sterno-mastoid without piercing the muscle. In one instance this nerve has been seen terminating in the sterno-mastoid muscle, the trapezius being supplied entirely by the third and fourth cervical nerves (Curnow).

## XII.—HYPOGLOSSAL NERVE.

The hypoglossal or twelfth cranial nerve (ninth pair of Willis) arises from the medulla oblongata by a series of from ten to fifteen fine roots which emerge along the groove separating the pyramid from the olivary body. The filaments are directed outwards above (or behind) the vertebral artery, and are usually collected into two bundles which perforate the dura mater separately opposite the anterior condylar foramen, and are united into a single trunk as they pass through that opening.

As it leaves the anterior condylar foramen the nerve is very deeply placed on the inner side of the deep cervical vessels and the pneumogastric nerve. Winding round the lower ganglion of the last, to which it is closely bound by connective tissue, the hypoglossal nerve descends, inclining at the same time gradually forwards between the internal carotid artery and jugular vein, to the lower border of the digastric muscle. At this level it curves forwards round the commencement of the occipital artery, the sterno-mastoid branch of which turns downwards over the nerve, and is thence directed forwards above the hyoid bone to the under part of the tongue. In the latter part of its course, it passes beneath the tendon of the digastric, the lower end of the stylo-hyoid and the mylo-hyoid muscles; it crosses the external carotid and the lingual arteries; and it rests upon the hyo-glossus muscle, being accompanied by the ranine vein of the tongue. At the anterior border of the hyo-glossus it is connected with the lingual branch of the fifth nerve, and then penetrates the fibres of the genio-glossus muscle, dividing into branches which are distributed to the muscular substance of the tongue.

Branches.—While passing through the anterior condylar foramen, the hypoglossal nerve gives off one or two minute twigs which ramify in the dura mater around the foramen magnum, and in the diploe of the occipital bone (Luschka). The branches arising from the nerve in the neck are partly filaments of communication with other nerves, but mainly offsets of distribution to muscles connected with the hyoid bone and larynx, and to the muscles of the tongue.

A. *Branches of communication.*

Close below the skull the hypoglossal nerve is united by a considerable twig with the superior cervical ganglion of the sympathetic, by one or more filaments with the loop between the first and second cervical nerves, and with the ganglion of the trunk of the vagus by fibres which pass between the two nerves where they are in close connection with one another.

As the nerve turns round the occipital artery, it is joined by the small lingual branch of the vagus (p. 582), and in the submaxillary region, it is connected with the lingual branch of the fifth nerve by one or two slender loops over the fore part of the hyo-glossus muscle.

Fig. 332.

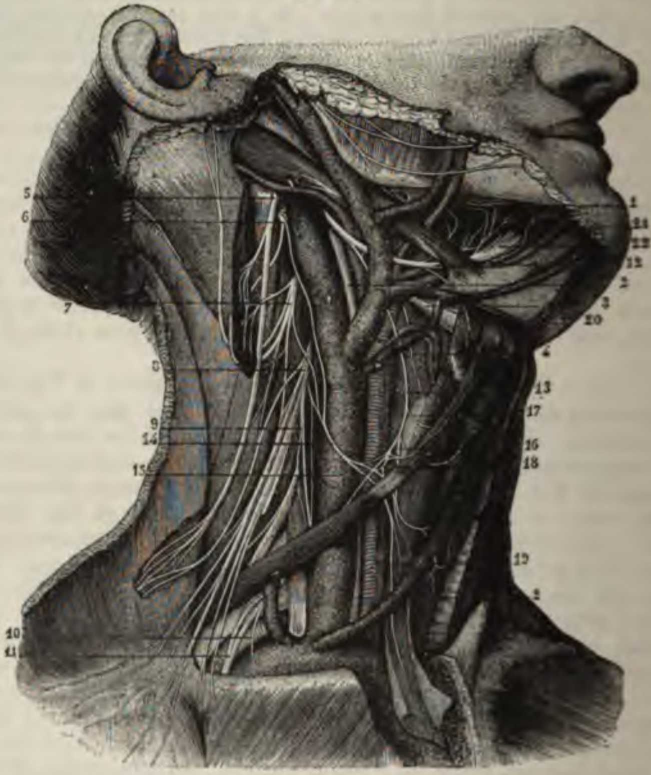

Fig. 332.—View of the distribution of the spinal accessory and hypoglossal nerves (from Sappey, after Hirschfeld and Leveillé). $\frac{1}{2}$

1, lingual nerve; 2, pneumo-gastric nerve; 3, superior laryngeal (represented too large); 4, external laryngeal branch; 5, spinal accessory; 6, second cervical; 7, third; 8, fourth; 9, origin of the phrenic nerve; 10, nerve to the subclavius muscle; 11, anterior thoracic nerves; 12, hypoglossal nerve; 13, its descending branch; 14, communicating branch from the cervical nerves; 15, 16, 18, 19, descending branches from the plexiform union of these nerves to the sterno-hyoid, sterno-thyroid and omohyoid muscles; 17, branch from the descendens noni to the anterior belly of the omo-hyoid muscle; 20, branch from the hypoglossal nerve to the thyro-hyoid muscle; 21, communicating twigs from the hypoglossal to the lingual nerve; 22, terminal branches of the hypoglossal nerve.

**B.** *Branches of distribution.*

**The descending branch** (r. descendens noni) leaves the trunk of the hypoglossal nerve as it crosses over the occipital artery, or a little higher up. It passes downwards on the surface of the common carotid artery, inclining gradually from the outer to the inner side, and being placed generally within, but sometimes on the front of, the carotid sheath. After having given off a branch to the anterior belly of the omo-hyoid muscle, it joins about the middle of the neck in a loop with one or two branches from the second and third cervical nerves (r. communicantes noni), giving rise to what is termed the *ansa hypoglossi.* The concavity of the loop is turned upwards, and the connection between the nerves is frequently effected by two or more interlacing filaments which form a small plexus. From this interlacement of the nerves, offsets are continued backwards to the posterior belly of the omo-hyoid, and downwards to the sterno-hyoid and sterno-thyroid muscles. Occasionally a filament is continued to the thorax, where it joins the cardiac and phrenic nerves.

**Muscular branches.**—The branch to the thyro-hyoid muscle is a separate twig arising from the hypoglossal trunk as it approaches the hyoid bone.

As it lies beneath the mylo-hyoid, the nerve gives offsets to the stylo-glossus, hyo-glossus and genio-hyoid muscles, and the terminal branches, penetrating the genio-glossus, supply that muscle and the intrinsic muscles of the tongue.

**Varieties.**—In one instance, recorded by Rüdinger, the hypoglossal nerve was found taking its superficial origin from the posterior surface of the medulla oblongata. The vertebral artery is not unfrequently found passing forwards between, very rarely above, the roots of the nerve. The right and left nerves are occasionally united by a cross branch or loop in the substance of the genio-hyoid, or between that and the genio-glossus muscle. In rare cases, the twelfth nerve gives filaments to the mylo-hyoid muscle (Krause).

The descending branch sometimes appears to be derived either altogether from the pneumo-gastric or from both the pneumo-gastric and hypoglossal nerves, but it can generally be shown by dissection that these varieties of origin are only apparent, resulting from the temporary adhesion of the filaments of this branch to those of the pneumo-gastric. It is probable, moreover, that the descendens noni has little if any real origin from the hypoglossal nerve, being formed (according to Luschka, E. Bischoff, Holl and others) of fibres derived from the upper cervical nerves, temporarily associated with the hypoglossal. It is also stated by Holl that the thyro-hyoid and genio-hyoid branches are similarly composed of fibres proceeding from the spinal nerves (Zeitsch. f. Anat., 1876).

In many animals the twelfth nerve possesses a posterior root furnished with a ganglion, like a spinal nerve.

SUMMARY.—The hypoglossal nerve supplies, either alone or in union with branches of the spinal nerves, all the muscles connected with the hyoid bone, including those of the tongue, but with the exception of the digastric, stylo-hyoid, mylo-hyoid and the middle constrictor of the pharynx. It also supplies the sterno-thyroid muscle.

It is connected with the following nerves, viz., pneumo-gastric, lingual, three upper cervical nerves, and the sympathetic.

Fig. 333.

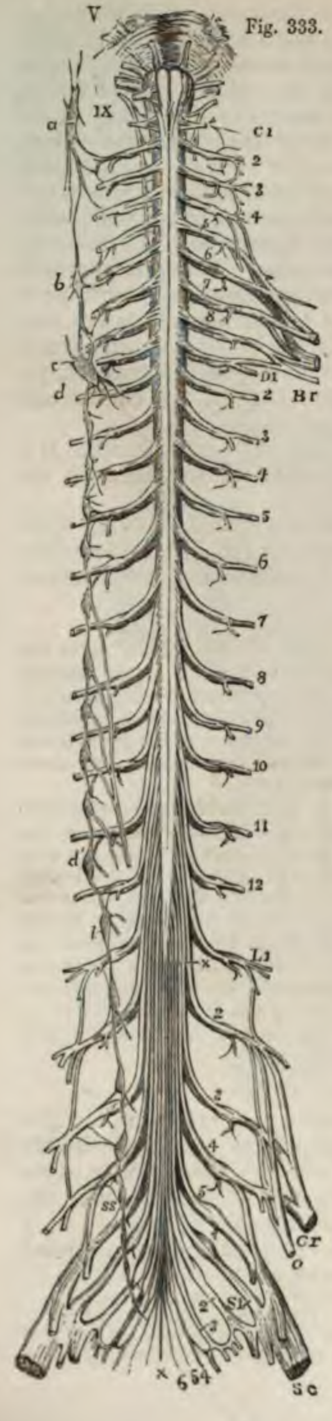

Fig. 333.—Diagrammatic outline of the roots and first part of the spinal nerves, together with the sympathetic trunk of one side. (A. T.) ¼

The view is taken from before. In the upper part of the figure the pons Varolii and medulla oblongata are represented, and from V to IX, the roots of the several cranial nerves from the trifacial to the hypoglossal are indicated. On the left side C 1, is placed opposite the first cervical or suboccipital nerve; and the numbers 2, to 8, following below indicate the corresponding cervical nerves; Br, indicates the brachial plexus; D 1, is placed opposite the intercostal part of the first dorsal nerve, and the numbers 2, to 12, following mark the corresponding dorsal nerves; L 1, the first lumbar nerve, and the numbers 2, to 5, following the remaining lumbar nerves; Cr, the anterior crural, and *o*, the obturator nerve; S 1, the first sacral, and the following numbers 2, to 5, the remaining sacral nerves; 6, the coccygeal nerve; Sc, great sciatic nerve; × ×, the filum terminale of the cord.

On the right side of the figure the following letters indicate parts of the sympathetic nerve, viz., *a*, the superior cervical ganglion communicating with the upper cervical spinal nerves and continued below into the great sympathetic cord; *b*, the middle cervical ganglion; *c*, *d*, the lower cervical ganglion united with the first dorsal; *d'*, the eleventh dorsal ganglion; from the fifth to the ninth dorsal ganglion the origins of the great splanchnic nerve are shown; *l*, the lowest dorsal or upper lumbar ganglion; *s s*, the upper sacral ganglion. In the whole extent of the sympathetic cord, the twigs of union with the spinal nerves are shown.

## SPINAL NERVES.

The spinal nerves are characterised by their origin from the spinal cord, and their direct transmission outwards from the spinal canal in the intervals between the vertebræ. There are, in all, thirty-one pairs of these nerves, and, according to the region in which they issue from the spinal canal, they are named cervical, dorsal, lumbar, sacral, and coccygeal.

By universal usage each pair of nerves in the dorsal, lumbar and sacral regions is named in correspondence with the vertebra below which it emerges. Of the eight pairs of nerves between the cranium and the first dorsal nerve, the uppermost is placed above the atlas, and the second and following nerves below the seven cervical vertebræ in succession. These the palm behind the annular ligament, and rests on the flexor tendons. Somewhat enlarged, and of a slightly reddish colour, it here separates into two parts of nearly equal size. One of these (the external) supplies some of the short muscles of the thumb, and gives digital branches to the thumb and the index finger; the second portion supplies the middle finger, and in part the index and ring fingers.

The median nerve usually gives no branch in the upper arm.

A.—*Branches in the forearm.*

(*a*) *Articular branches.*—These are one or two filaments to the front of the elbow-joint (Rüdinger).

(*b*) *Muscular branches* arise either together or separately in the neighbourhood of the elbow and pass to the pronator teres, flexor carpi radialis, palmaris longus and flexor sublimis digitorum. A second branch to the flexor sublimis is usually given off by the trunk at a lower level in the forearm.

(*c*) *Anterior interosseous nerve.*—This is the longest branch of the median nerve, and it supplies the deeper muscles of the front of the forearm. Leaving the main trunk a little below the elbow, it runs downwards with the artery of the same name on the interosseous membrane to the deep surface of the pronator quadratus muscle, in which it ends. It distributes branches to the flexor longus pollicis and the outer half of the flexor profundus digitorum between which it lies; other filaments are supplied to the interosseous membrane and the bones of the forearm (Rauber, "Ueber die Nerven der Knockenhaut," &c., München, 1868); and from its lower end a twig is continued to the front of the wrist-joint.

(*d*) The *palmar cutaneous branch* arises a variable distance above the wrist, and pierces the fascia of the forearm close to the annular ligament, to terminate in the integument of the palm, where it communicates with the palmar cutaneous branch of the ulnar nerve. Some filaments are distributed over the ball of the thumb, and form communications with twigs of the radial or external cutaneous nerve.

B. *Branches in the hand.*

Fig. 345.

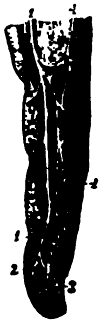

**Fig. 345.**—Distribution of the digital nerves (from Hirschfeld and Leveillé). $\frac{1}{2}$

1, palmar collateral nerve; 2, its final palmar distribution; 3, its dorsal or ungual distribution, and between these numbers the network of terminal filaments; 4, dorsal collateral nerve; 5, uniting twigs passing between the dorsal and palmar digital nerves.

(*a*) *Branch to muscles of the thumb.*—This short nerve subdivides into branches for the abductor, the opponens, and the outer head of the flexor brevis pollicis muscles.

(*b*) *Digital nerves.*—These are five in number, and belong to the thumb, and the fingers as far as the outer side of the ring-finger. As they approach the clefts between the fingers, they are close to the integument in the intervals between the longitudinal divisions of the palmar fascia.

The *first* and *second* nerves lie along the sides of the thumb; and the former (the outer one) is connected with the radial nerve over the border of the thumb.

The *third*, destined for the radial side of the index finger, gives a branch to the first or most external lumbricalis muscle.

The *fourth* supplies the second lumbricalis, and divides into collateral branches for the adjacent sides of the index and middle fingers.

The *fifth*, the most internal of the digital nerves, is connected by a cross branch with the ulnar nerve, and divides to supply the adjacent sides of the ring and middle fingers.

Each digital nerve divides at the end of the finger into two branches, one of which supplies the ball on the fore part of the finger, while the other ramifies in the pulp beneath the nail. Branches pass from each nerve forwards and backwards to the integument of the finger; those passing backwards join the dorsal collateral nerve, and supply mainly the integument over the second and third phalanges.

**Varieties.**—One or both heads of the median may be double, and the outer head may pass behind, instead of in front of, the axillary artery. The whole nerve is sometimes found passing behind the brachial artery (p. 414). Gruber and Walsh have recorded cases in which the nerve entered the forearm over the pronator teres muscle. The median nerve is often connected in the arm with the musculo-cutaneous (p. 610), in the forearm with the ulnar nerve (p. 612).

SUMMARY.—The median nerve gives cutaneous branches to the palm, and to three and a half fingers. It supplies the pronator muscles, the flexors of the carpus and the long flexors of the fingers (except the ulnar flexor of the carpus, and part of the deep flexor of the fingers), likewise the outer set of the short muscles of the thumb, and two lumbricales.

A great similarity will be observed in the distribution of the median and ulnar nerves. Neither gives any offset in the arm. Together they supply all the muscles of the front of the forearm and in the hand, and together they supply the skin of the palmar surface of the hand, and impart tactile sensibility to all the fingers.

**Musculo-spiral nerve.**—The musculo-spiral nerve, the largest offset from the brachial plexus, occupies chiefly the back part of the limb, and supplies nerves to the extensor muscles, as well as to the skin.

Arising behind the axillary vessels from the posterior cord of the brachial plexus, of which it is the principal continuation and the only branch prolonged into the arm, it soon turns backwards into the musculo-spiral groove, and, accompanied by the superior profunda artery, proceeds along that groove, between the humerus and the triceps muscle, to the outer side of the limb. It then pierces the external intermuscular septum, and descends in the interval between the supinator longus and brachialis anticus muscles to the level of the outer condyle of the humerus, where it ends by dividing into the *radial* and *posterior interosseous nerves*. Of these, the radial is altogether a cutaneous nerve, while the posterior interosseous is the muscular nerve of the back of the forearm.

The branches of the musculo-spiral nerve may be classified according as they arise on the inner side of the humerus, behind that bone, or on the outer side.

A. *Internal branches.*

(*a*) *Muscular branches* for the inner and long heads of the triceps. That for the inner head gives two or three filaments to the upper part of the muscle, and then descends by the ulnar nerve, to which it is often closely adherent for a part of its course, and enters the lower short fibres of the head. This long filament is named by Krause the *ulnar collateral branch*.

(*b*) The *internal cutaneous branch* of the musculo-spiral nerve, commonly united in origin with the preceding, winds backwards beneath the intercosto-humeral nerve, and extends, supplying filaments to the skin, nearly as far as the olecranon. This nerve is accompanied by a small cutaneous artery.

B. *Posterior branches.*

These consist of a fasciculus of *muscular branches* which supply the outer and inner heads of the triceps muscle and the anconeus. The *branch of the anconeus* is slender, and remarkable for its length; it descends in the substance of the triceps to reach its destination.

C. *External branches.*

(*a*) *Muscular branches* to the supinator longus, extensor carpi radialis longior (the extensor carpi radialis brevior usually receiving its nerve from the posterior interosseous), and frequently a small twig to the outer part of the brachialis anticus.

Fig. 346.

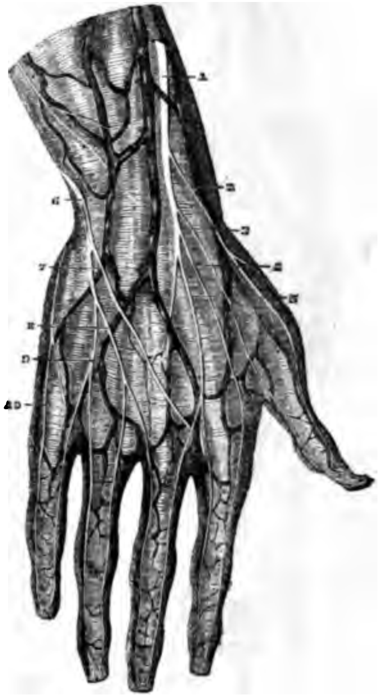

Fig. 346.—Dorsal cutaneous nerves of the hand. ½

The distribution delineated in this figure is not the most common, there being a larger branch of the ulnar nerve than usual: 1, the radial nerve descending beside the radial vein; 2 and 3, dorsal branches to the two sides of the thumb; 4, branch to the radial side of the forefinger; 5, branch to the forefinger and middle finger, communicating with one from the ulnar nerve; 6, dorsal branch of the ulnar nerve; 7, communicating twig; 8, digital branch to the middle and ring fingers; 9, branch to the ring and little fingers; 10, branch to the inner side of the hand and little finger.

(*b*) The *external cutaneous branches*, two in number, arise where the nerve pierces the external intermuscular septum.

The *upper branch*, the smaller of the two, is directed downwards to the fore part of the elbow, along the cephalic vein, and distributes filaments to the lower half of the upper arm on its outer and anterior aspect. The *lower branch* extends as far as the wrist, distributing offsets to the lower half of the arm, and to the forearm, on their posterior aspect, and is connected near the wrist with a branch of the external cutaneous nerve.

**Radial nerve.**—The radial nerve, continuing straight down from the musculo-spiral, is concealed by the long supinator muscle, and lies a little to the outer side of the radial artery. This position beneath the supinator is retained to about three inches from the lower end of the radius, where the nerve turns backwards beneath the tendon of the muscle, and becomes subcutaneous. It then divides into two branches, which ramify in the integument on the dorsal aspect of the thumb and the next two fingers in the following manner.

immediately beyond the points at which the roots perforate the dura mater lining the spinal canal. The first and second cervical nerves, however, which leave the spinal canal over the laminæ of the vertebræ, have their ganglia opposite those parts. The ganglia of the sacral nerves are contained in the spinal canal, that of the last nerve being occasionally at some distance from the point at which the nerve issues. The ganglion of the coccygeal nerve is placed within the canal in the sac of dura mater, and at a variable distance from the origin of the nerve.

The fibres of the posterior root of the nerve are collected into two bundles as they approach the ganglion, and the inner extremity of the oval-shaped ganglion is usually bilobate, the lobes corresponding to the two bundles of fibres.

The *anterior roots* of the spinal nerves are smaller than the posterior, and are devoid of ganglia. Their fibres are also collected into two bundles near the intervertebral ganglion.

**Size.**—The roots of the upper *cervical nerves* are smaller than those of the lower nerves, the first being much the smallest. The posterior roots of these nerves, with the exception of the first in which the anterior root is larger than the posterior, exceed the anterior in size more than in the other spinal nerves, and they are likewise composed of fasciculi which are considerably larger than those of anterior roots.

The roots of the *dorsal nerves*, exception being made of the first, which resembles the lowest cervical nerves and is associated with them in a part of its distribution, are of small size, and vary but slightly, or not at all, from the second to the last. The fasciculi of both roots are thinly strewed over the spinal cord, and are slender, those of the posterior exceeding in thickness those of the anterior root in only a small degree.

The roots of the lower *lumbar*, and of the upper *sacral nerves*, are the largest of all the spinal nerves; those of the lowest sacral and of the coccygeal nerve are, on the other hand, the smallest. All these nerves are crowded together upon the lower end of the cord. Of these nerves the anterior roots are the smaller, but the disproportion between the anterior and posterior roots is not so great as in the cervical nerves.

**Length.**—The place at which the roots of the upper cervical nerves are connected with the spinal cord being nearly opposite the foramina by which they respectively leave the canal, these roots are comparatively short. But the distance between the two points referred to is gradually augmented from nerve to nerve downwards, so that the place of origin of the lower cervical nerves is the depth of at least one veretebra, and that of the lower dorsal nerves about the depth of two vertebræ, above the foramina by which they respectively emerge from the canal. Moreover, as the spinal cord extends no farther than the first lumbar vertebra, the length of the roots of the lumbar, sacral and coccygeal nerves increases rapidly from nerve to nerve, and in each case may be estimated by the distance of the foramen of exit from the extremity of the cord. Owing to their length, and the appearance they present in connection with the spinal cord, the aggregation of the roots of the nerves last referred to has been named the *cauda equina*.

The *direction* the roots take within the canal requires brief notice. The first cervical nerve is directed horizontally outwards. The roots of the lower cervical and dorsal nerves at first descend over the spinal cord, held in contact with it by the arachnoid, till they arrive opposite the muscles, the nerve lies at the back of the wrist beneath the tendons of the extensor indicis and the common extensor of the fingers, and forms here a small gangliform enlargement, from which filaments are given to the adjoining ligaments and articulations.

*Branches.*—(*a*) *Muscular branches.*—Before the nerve passes to the back of the forearm it gives offsets to the extensor carpi radialis brevior and the supinator brevis muscles. After perforating the supinator brevis, it supplies branches to the extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, the three extensors of the thumb, and the extensor indicis.

(*b*) *Articular branches.*—From the terminal enlargement of the nerve fine twigs proceed to the articulations of the wrist, and, according to Rüdinger and Rauber, other filaments descend on the back of the hand to the metacarpo-phalangeal articulations.

**Varieties.**—The dorsal branch of the radial nerve sometimes supplies the whole of the back of the hand and fingers. In two cases, recorded by Turner and Schwalbe, the posterior interosseous nerve passed down to supply the adjacent sides of the index and middle fingers.

SUMMARY.—The musculo-spiral nerve distributes its branches to the extensor muscles of the elbow-joint and sometimes sends a filament to the brachialis anticus, which, however, receives its principal supply from another source. Before separating into its two large divisions, the nerve gives branches to two muscles of the forearm, viz., the long supinator, and the long radial extensor of the carpus. The posterior interosseous division distributes nerves to the remaining muscles on the outer and back part of the forearm, except the anconeus (previously supplied), viz., to the short supinator and the extensors.

Cutaneous nerves are distributed, from the trunk of the nerve and its radial division, to the upper arm, to the forearm, and to the hand—on the posterior and outer aspect of each.

## DORSAL NERVES.

The anterior divisions of the twelve dorsal nerves are distributed almost entirely to the walls of the thorax and abdomen. The exceptions are the first, the greater part of which joins the brachial plexus, and the second and twelfth, which send cutaneous offsets to the arm and hip respectively. Close to the intervertebral foramina, these nerves are connected to the gangliated cord of the sympathetic by very short communicating branches; they are then directed transversely outwards to their destination without forming any plexus, and in this respect they differ from the anterior primary divisions of the other spinal nerves. The smaller part of the first, and the trunks of the succeeding ten nerves pass forwards in the intercostal spaces, and are thence termed *intercostal nerves.* Of these, the upper six are confined to the parietes of the thorax, while the lower five are continued anteriorly from the intercostal spaces into the wall of the abdomen. The twelfth nerve is placed below the last rib, and is therefore contained altogether in the abdominal wall.

### FIRST DORSAL NERVE.

The anterior division of the first dorsal nerve divides into two parts, the larger of which ascends over the neck of the first rib to enter into the brachial plexus. The remaining portion of the nerve is continued as

Fig. 335.

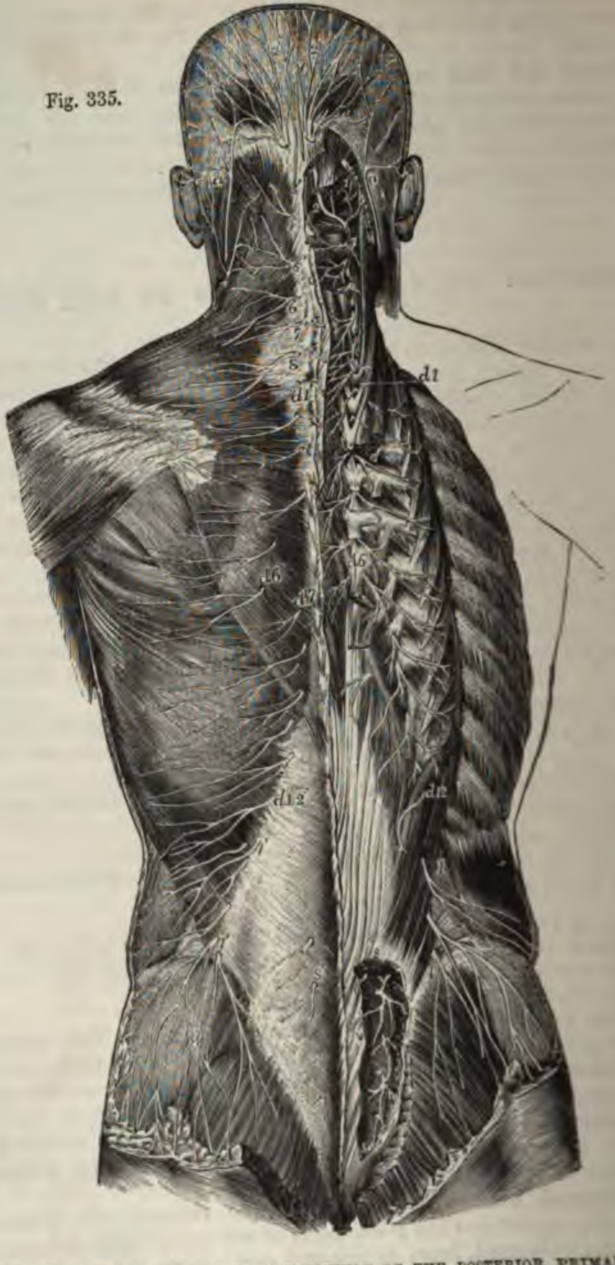

Fig. 335.—SUPERFICIAL AND DEEP DISTRIBUTION OF THE POSTERIOR PRIMARY OF THE SPINAL NERVES (after Hirschfeld and Leveillé). ¼

On the left side the cutaneous branches are represented as lying upon the muscles; on the right side, these muscles having been removed, the splenius

## ANTERIOR PRIMARY DIVISIONS OF THE SPINAL NERVES.

The anterior primary divisions of the spinal nerves are distributed to the parts of the body situated in front of the vertebral column, including the limbs. They are, for the most part, considerably larger than the posterior divisions.

The anterior division of each spinal nerve is connected by one or two slender filaments with the sympathetic. Those of the cervical, lumbar, and sacral nerves form plexuses of various forms ; but those of the dorsal nerves remain for the most part separate from one another.

### CERVICAL NERVES.

The anterior divisions of the four upper cervical nerves form the cervical plexus. They appear at the side of the neck between the scalenus medius and rectus anticus major muscles. They are each united by a communicating filament to the first cervical ganglion of the sympathetic nerve, or to the cord connecting that ganglion with the second.

The anterior divisions of the four lower cervical nerves, larger than those of the upper four, appear between the anterior and middle scaleni muscles, and, together with the larger part of the first dorsal, go to form the brachial plexus. They are each connected by a filament with one of the two lower cervical ganglia of the sympathetic, and with the plexus on the vertebral artery.

The anterior divisions of the first and second nerves require a notice separately from the description of the nerves of the cervical plexus.

### SUBOCCIPITAL NERVE.

The anterior primary division of the first nerve runs forwards in a groove on the outer side of the upper articular process of the atlas, and bends downwards in front of the transverse process of that vertebra to join the second nerve. In this course forwards it lies beneath the vertebral artery, and on the inner side of the rectus lateralis muscle, to which it gives a branch. As it crosses the inner side of the foramen in the transverse process of the atlas, the nerve is joined by a filament from the sympathetic on the vertebral artery ; and from the loop which it makes in front of the transverse process, branches are supplied to the two anterior recti muscles. Short filaments connect this part of the nerve with the pneumo-gastric, the hypoglossal, and the sympathetic nerves.

Valentin notices filaments distributed to the articulation of the occipital bone with the atlas, and to the mastoid process of the temporal bone.

### SECOND CERVICAL NERVE.

The anterior division of the second cervical nerve, beginning between the arches of the first two vertebræ, is directed forwards between their transverse processes, being placed outside the vertebral artery, and beneath the posterior intertransverse and other muscles fixed to those processes. In front of the intertransverse muscles, the nerve divides into an ascending part, which joins the first cervical nerve, and a descending part to the third.

generally none from the external branches of the same nerves, and *vice versâ.*

LUMBAR NERVES.—The **external branches** enter the erector spinæ, and give filaments to the intertransverse muscles. From the upper three, cutaneous nerves are supplied; and from the last, a fasciculus descends to the corresponding branch of the first sacral nerve. The *cutaneous nerves* given from the external branches of the first three lumbar nerves pierce the fleshy part of the ilio-costalis and the aponeurosis of the latissimus dorsi: they cross the iliac crest near the edge of the erector spinæ, and terminate in the integument of the gluteal region. One or more of the filaments may be traced as far as the great trochanter of the femur.

The **internal branches** wind backwards in grooves close to the articular processes of the vertebræ, and sink into the multifidus spinæ muscle.

SACRAL NERVES.—The posterior divisions of these nerves, except the last, issue from the sacrum through its posterior foramina. The first three are covered at their exit from the bone by the multifidus spinæ muscle, and bifurcate like the posterior trunks of the other spinal nerves: but the remaining two, which continue below that muscle, have a peculiar arrangement, and require separate examination.

The **internal branches** *of the first three sacral nerves* are small, and are lost in the multifidus spinæ muscle.

The **external branches** of the same nerves are united with one another, and with the last lumbar and fourth sacral nerves, so as to form a series of anastomotic loops on the upper part of the sacrum. From these, branches are then directed outwards to the cutaneous or posterior surface of the great sacro-sciatic ligament, where, covered by the gluteus maximus muscle, they form a second series of loops, and end as cutaneous nerves. The latter pierce the great gluteus muscle in the direction of a line from the posterior superior iliac spine to the tip of the coccyx. They are commonly two in number—one is near the lower part of the sacrum, the other by the side of the coccyx. All are directed outwards over the great gluteal muscle.

In six dissections by Ellis this arrangement was found to be the most frequent. The variations to which it is liable are these:—the first nerve may not take part in the formation of the second series of loops, and the fourth may be associated with them.

The posterior divisions of the *last two sacral nerves* are smaller than those above them, and are not divided into external and internal branches. They are connected with each other by a loop on the back of the sacrum, and the lowest is joined in a similar manner with the coccygeal nerve; one or two filaments from these sacral nerves are distributed in the neighbourhood of the coccyx.

COCCYGEAL NERVE.—The posterior division of the coccygeal nerve is very small, and separates from the anterior primary portion of the nerve in the sacral canal. It is joined by a communicating filament from the last sacral nerve, and ends in the integument over the posterior surface of the coccyx.

## ANTERIOR PRIMARY DIVISIONS OF THE SPINAL NERVES.

The anterior primary divisions of the spinal nerves are distributed to the parts of the body situated in front of the vertebral column, including the limbs. They are, for the most part, considerably larger than the posterior divisions.

The anterior division of each spinal nerve is connected by one or two slender filaments with the sympathetic. Those of the cervical, lumbar, and sacral nerves form plexuses of various forms; but those of the dorsal nerves remain for the most part separate from one another.

### CERVICAL NERVES.

The anterior divisions of the four upper cervical nerves form the cervical plexus. They appear at the side of the neck between the scalenus medius and rectus anticus major muscles. They are each united by a communicating filament to the first cervical ganglion of the sympathetic nerve, or to the cord connecting that ganglion with the second.

The anterior divisions of the four lower cervical nerves, larger than those of the upper four, appear between the anterior and middle scaleni muscles, and, together with the larger part of the first dorsal, go to form the brachial plexus. They are each connected by a filament with one of the two lower cervical ganglia of the sympathetic, and with the plexus on the vertebral artery.

The anterior divisions of the first and second nerves require a notice separately from the description of the nerves of the cervical plexus.

### SUBOCCIPITAL NERVE.

The anterior primary division of the first nerve runs forwards in a groove on the outer side of the upper articular process of the atlas, and bends downwards in front of the transverse process of that vertebra to join the second nerve. In this course forwards it lies beneath the vertebral artery, and on the inner side of the rectus lateralis muscle, to which it gives a branch. As it crosses the inner side of the foramen in the transverse process of the atlas, the nerve is joined by a filament from the sympathetic on the vertebral artery; and from the loop which it makes in front of the transverse process, branches are supplied to the two anterior recti muscles. Short filaments connect this part of the nerve with the pneumo-gastric, the hypoglossal, and the sympathetic nerves.

Valentin notices filaments distributed to the articulation of the occipital bone with the atlas, and to the mastoid process of the temporal bone.

### SECOND CERVICAL NERVE.

The anterior division of the second cervical nerve, beginning between the arches of the first two vertebræ, is directed forwards between their transverse processes, being placed outside the vertebral artery, and beneath the posterior intertransverse and other muscles fixed to those processes. In front of the intertransverse muscles, the nerve divides into an ascending part, which joins the first cervical nerve, and a descending part to the third.

perforated the deep fascia near the cranium, the small occipital nerve ascends to the scalp between the ear and the great occipital nerve, and ends in cutaneous filaments which extend upwards to somewhat above the level of the ear. It communicates with branches from the great occipital, great auricular and posterior auricular nerves, and it supplies an *auricular branch* which is distributed to the upper part of the ear on its inner aspect.

**Varieties.**—The small occipital nerve is sometimes directed backwards across the posterior triangle of the neck, and perforates the trapezius muscle close to its upper border, before ascending to the head. The auricular branch may be derived from the great occipital nerve when the small occipital is of less size than usual.

### SUPERFICIAL DESCENDING BRANCHES.

**Supraclavicular nerves.**—The descending series of the superficial nerves are thus named. They arise together from the third and fourth cervical nerves, and descend in the interval between the sterno-mastoid and the trapezius muscles. As they approach the clavicle, they are three or more in number, and are recognized as internal, middle, and external.

(*a*) The *internal branch* (suprasternal), which is much smaller than the rest, ramifies over and below the inner third of the clavicle, and terminates near the sternum.

(*b*) The *middle branch* (supraclavicular), generally divided into two or three parts, and crossing the clavicle in the interval between the sterno-mastoid and trapezius muscles, distributes some twigs over the fore part of the deltoid, and others over the pectoral muscle as low as the fourth rib. The latter join the small anterior cutaneous branches of some of the upper intercostal nerves.

(*c*) The *external* or *posterior branch* (supra-acromial) is directed outwards across the clavicular attachment of the trapezius muscle, and ramifies over the acromion and in the integument of the outer and back part of the shoulder.

**Variety.**—One of the middle branches of the supraclavicular nerves occasionally perforates the clavicle on its way downwards.

### DEEP BRANCHES: INTERNAL SERIES.

**Connecting branches.**—The cervical plexus is connected near the base of the skull with the pneumo-gastric, hypoglossal, and sympathetic nerves, by means of filaments intervening between those nerves and the loop formed by the first two cervical nerves in front of the atlas (p. 597).

**Muscular branches.**—*Branches to the prevertebral muscles* proceed from the cervical nerves close to the vertebræ, including the loop between the first two of these nerves.

*Two branches to the ansa hypoglossi* (rami communicantes noni), one from the second, the other from the third cervical nerve, descend over or under the internal jugular vein, to form a loop of communication with the descending branch of the hypoglossal nerve, and aid in the supply of the infrahyoid muscles (p. 589).

**Phrenic nerve.**—The diaphragmatic or phrenic nerve passes down through the lower part of the neck and the thorax to its destination.

It arises mainly from the fourth cervical nerve, but it also receives, in the majority of instances, an additional root from either the third or the fifth nerve. While descending in the neck, the nerve inclines

Fig. 337.

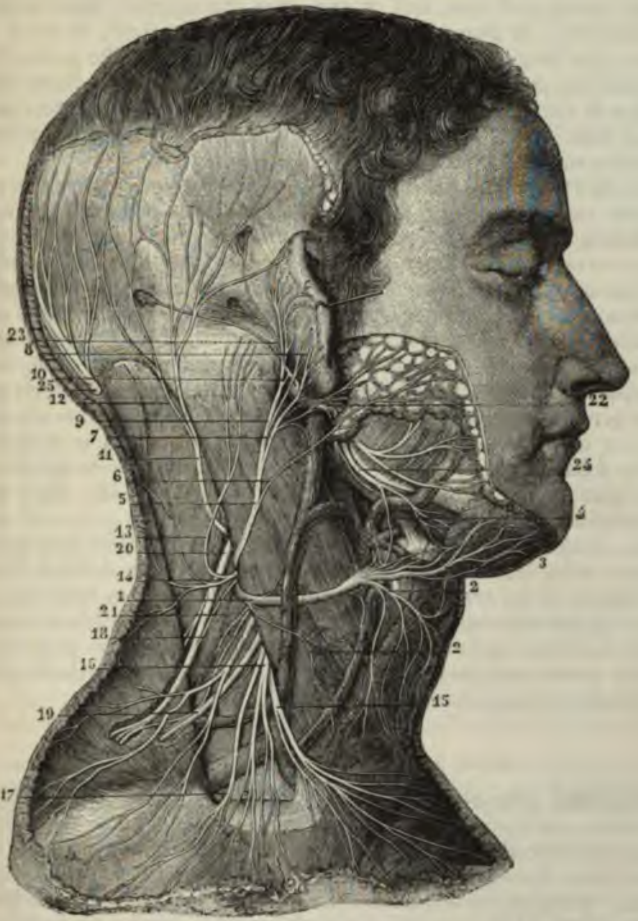

Fig. 337.—THE SUPERFICIAL BRANCHES OF THE CERVICAL PLEXUS (from Sappey after Hirschfeld and Leveillé). ⅓

1, superficial cervical nerve; 2, its inferior branch; 3, its superior branch; 4, its union with the facial; 5, great auricular nerve; 6, one of its facial branches; 7, its branch to the lobule; 8, twig which pierces the auricle to pass to its outer surface; 9, branch to the deep surface of the pinna; 10, its union with the posterior auricular of the facial nerve; 11, small occipital nerve; 12, its branch which unites with the great occipital nerve; 13, a mastoid branch or second small occipital; 14, twigs from this to the back of the neck; 15, inner, 16, 17, middle, 18, outer branches of the supraclavicular nerves; 19, branch of the cervical nerves passing into the trapezius muscle; 20, spinal accessory distributed to the same and receiving a uniting branch from the cervical nerves; 21, branch to the levator scapulæ; 22, trunk of the facial nerve; 23, its posterior auricular branch passing into the occipital and posterior and superior auricular muscles; 24, its inframaxillary branch; 25, great occipital nerve.

inwards over the anterior scalenus muscle; and near the chest it is joined by a filament of the sympathetic, sometimes also by another filament given off by the branch proceeding from the fifth and sixth cervical nerves to the subclavius muscle.

As it enters the thorax each phrenic nerve is placed between the subclavian artery and vein, and crosses over the internal mammary artery near its root. It then takes a nearly straight direction, in front of the root of the lung on each side, and along the side of the pericardium—between this and the mediastinal part of the pleura. Near the diaphragm it divides into branches, which separately penetrate the fibres of that muscle, and then diverging from each other, are distributed on the under surface.

The *right nerve* is placed more deeply than the left, and is at first directed along the outer side of the right innominate vein and the descending vena cava.

The *nerve* of the *left side* is a little longer than that of the right, in consequence of the oblique position of the pericardium round which it winds, and also because the diaphragm is lower on this than on the opposite side. This nerve crosses in front of the left vagus and the arch of the aorta before reaching the pericardium.

Besides the terminal branches supplied to the diaphragm, each phrenic nerve gives filaments to the pleura and pericardium, and receives sometimes an offset from the union of the descending branch of the hypoglossal with the cervical nerves. Luschka describes twigs from the lower part of the nerve to the peritoneum, and on the right side to the inferior cava and the right auricle of the heart.

One or two filaments of the nerve of the right side join in a small ganglion with branches to the diaphragm which are derived from the solar plexus of the sympathetic; and from the ganglion twigs are given to the suprarenal capsule, the hepatic plexus, and the lower vena cava. On the left side there is a junction between the phrenic and the sympathetic nerves near the œsophageal and aortic openings in the diaphragm, but without the appearance of a ganglion.

### DEEP BRANCHES: EXTERNAL SERIES.

**Muscular branches.**—The sterno-mastoid receives a branch from the second cervical nerve. Two branches proceed from the third and fourth nerves to the levator anguli scapulæ; and from the same nerves, as they leave the spinal canal, branches are given to the middle scalenus muscle. Farther, the trapezius receives one or more considerable branches which arise from the third and fourth cervical trunks in common with the supraclavicular nerves.

*Connection with the spinal accessory nerve.*—In the substance of the sterno-mastoid muscle, this nerve is connected with the branch of the cervical plexus furnished to that muscle. It is also connected with the branches distributed to the trapezius—the union between the nerves being beneath the muscle, and having the appearance of a plexus; and with another branch of the cervical plexus in the interval between the two muscles.

SUMMARY OF THE CERVICAL PLEXUS.—From the cervical plexus cutaneous nerves are distributed to the side of the head, to part of the ear and face, to the anterior half or more of the neck, and to the upper

**The lateral cutaneous branch** of the last dorsal nerve, passing through both oblique muscles, is directed downwards over the iliac crest to the integument covering the fore part of the gluteal region, some filaments reaching as far as the great trochanter of the femur.

### LUMBAR NERVES.

The anterior divisions of the lumbar nerves increase in size from the first to the fifth ; and all, except the fifth, which passes down to join the sacral nerves, are connected together in loops, so as to form the lumbar plexus. On leaving the intervertebral foramina, the nerves are connected by filaments with the cord of the sympathetic, these filaments being longer than those connected with other spinal nerves, in consequence of the position of the lumbar sympathetic ganglia on the fore part of the bodies of the vertebræ. In the same situation small twigs are furnished to the psoas and quadratus lumborum muscles.

### LUMBAR PLEXUS.

The lumbar plexus is formed by the communications between the anterior primary divisions of the four upper lumbar nerves. It is placed in the substance of the psoas muscle, in front of the transverse processes of the corresponding vertebræ. Above, the plexus is narrow, and is usually connected with the last dorsal nerve by a small offset from that nerve, named dorsi-lumbar ; below, it is wider, and is joined to the sacral plexus by means of a branch passing from the fourth lumbar nerve to the fifth.

The arrangement of the plexus may be thus stated. The first nerve gives off the ilio-hypogastric and ilio-inguinal nerves, and sends downwards a communicating branch to the second nerve. The second furnishes the greater part of the genito-crural and external cutaneous nerves, and gives a connecting branch to the third, from which some of the fibres of the anterior crural and obturator nerves are derived. From the third nerve two branches proceed ; one of these, the larger, forms part of the anterior crural nerve ; the other, a part of the obturator nerve. The fourth nerve gives three branches, two of which serve to complete the obturator and anterior crural nerves, while the third is a connecting branch to the fifth nerve, and enters into the formation of the sacral plexus.

The BRANCHES of the lumbar plexus form two sets, which are distributed, one to the lower part of the wall of the abdomen, the other to the fore part and inner side of the lower limb. In the former set are the ilio-hypogastric and ilio-inguinal nerves, and part of the genito-crural ; and to the latter belong the remaining part of the genito-crural nerve, the external cutaneous, the obturator, and the anterior crural nerves.

**Ilio-hypogastric and ilio-inguinal nerves.**—These nerves are the upper two branches from the lumbar plexus ; they are both derived from the first lumbar nerve, and have a nearly similar distribution. They become subcutaneous by passing between and through the broad muscles of the abdomen, and end in the integument of the groin and scrotum in the male, and the labium pudendi in the female, as well as in the integument of the gluteal region. The extent of distribution of the one is inversely proportional to that of the other.

boid muscles, another for the subclavius, branches for the scaleni and longus colli muscles, and sometimes a branch to join the phrenic nerve.

**Small muscular branches.**—The branches for *the scaleni* and *longus colli muscles* spring in an irregular manner from the lower cervical nerves close to their place of emergence from the intervertebral foramina.

Fig. 338.

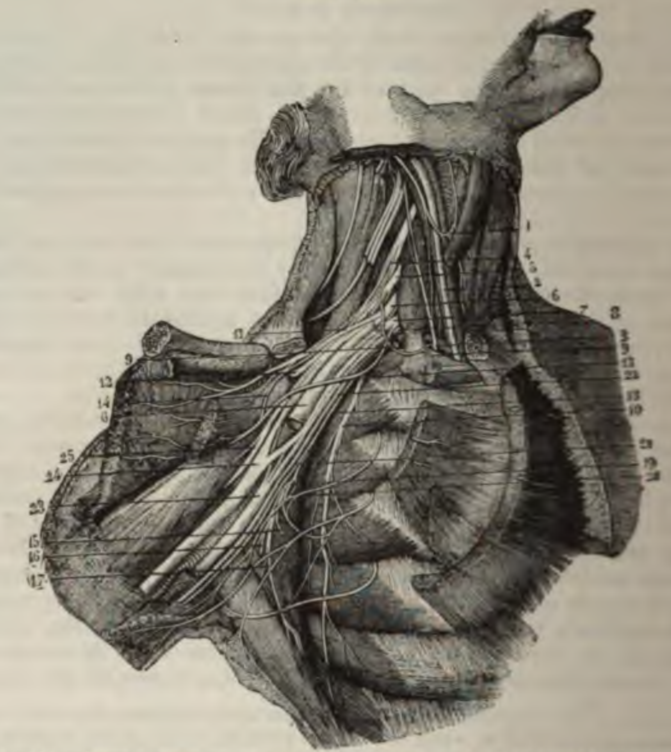

Fig. 338.—DEEP DISSECTION OF THE AXILLA, SHOWING THE BRACHIAL PLEXUS AND NEIGHBOURING NERVES (from Sappey, after Hirschfeld and Leveillé). ½

The clavicle has been sawn through near its sternal end, and is turned aside with the muscles attached to it; the subclavius and the greater and lesser pectoral muscles have been removed from the front of the axilla: 1, ansa hypoglossi; 2, pneumo-gastric; 3, phrenic, passing down to the inner side of the scalenus anticus muscle; 4, anterior primary division of the fifth cervical nerve; 5, 6, 7, the same of the sixth, seventh, and eighth cervical nerves; 8, the same of the first dorsal nerve; 9, 9, nerve to the subclavius muscle, communicating with the phrenic nerve; 10, posterior thoracic nerve distributed to the serratus magnus; 11, external anterior thoracic nerve, passing into the great pectoral muscle; 13, internal anterior thoracic, distributed to the lesser pectoral; 14, twig of communication between these two nerves; 12, suprascapular nerve, passing through the suprascapular notch; 15, upper subscapular nerve; 16, lower subscapular nerve; 17, long subscapular nerve; 18, 21, small internal cutaneous nerve; 19, union of this with the second and third intercostal nerves; 20, lateral branch of the second intercostal; 22, internal cutaneous nerve; 23, ulnar nerve to the inside of the axillary artery, passing behind the vein, and having, in this case, a root from the outer cord of the plexus; 24, median nerve immediately below the place where its two roots embrace the artery, which is divided above this place: 25, musculo-cutaneous nerve, passing into the coraco-brachialis muscle; 26, musculo-spiral nerve, passing behind the divided axillary artery.

The branch for *the rhomboid muscles* arises from the fifth nerve, and is directed backwards to the base of the scapula through the fibres of the middle scalenus, and beneath the levator anguli scapulæ to the deep surface of the rhomboid muscles, in which it terminates. It gives one or two branches to the levator scapulæ, and sometimes a twig to the highest digitation of the serratus posticus superior (Rieländer).

The nerve *of the subclavius muscle*, of small size, arises from the front of the cord which results from the union of the fifth and sixth cervical nerves. It is directed over the third part of the subclavian artery to the deep surface of the subclavius muscle. This small nerve is frequently connected with the phrenic nerve in the neck, or in the chest, by means of a slender filament.

Branch *to join the phrenic nerve.*—This small and short branch is, when present, an offset from the fifth cervical nerve ; it joins the phrenic nerve on the anterior scalenus muscle.

Fig. 339.

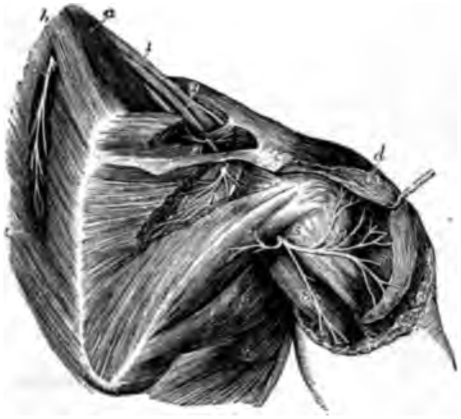

Fig. 339. — DISTRIBUTION OF THE SUPRASCAPULAR AND CIRCUMFLEX NERVES (from Hirschfeld and Leveillé). ½

*a*, scalenus medius and posticus muscles ; *b*, levator anguli scapulæ ; *c*, acromion ; *d*, deltoid muscle, of which the back part has been removed ; *e*, rhomboid muscles ; *f*, teres major ; *g*, latissimus dorsi ; 1, the brachial plexus, seen from behind ; 1′, nerve to the rhomboid muscles ; 2, placed on the clavicle, the suprascapular nerve ; 3, its branches to the supraspinatus muscle ; 4, branch to the infraspinatus ; 5, the circumflex nerve, passing out of the quadrangular interval ; 6, its branch to the teres minor muscle ; 7, branches to the deltoid ; 8, cutaneous branch.

**Posterior thoracic nerve**.—The posterior thoracic nerve (nerve of the serratus magnus) is generally formed in the substance of the middle scalenus muscle by two roots, one from the fifth and another from the sixth nerve, and reaches the surface of the scalenus lower than the nerve of the rhomboid muscles, with which it is often connected. It descends behind the brachial plexus on the outer surface of the serratus magnus, nearly to the lower border of that muscle, supplying it with numerous branches.

**Suprascapular nerve**.—The suprascapular nerve arises from the cord formed by the union of the fifth and sixth nerves, and passes outwards and backwards beneath the trapezius to the upper border of the scapula, where it enters the supraspinous fossa through the suprascapular notch, below the ligament of the same name. In the supraspinous fossa, the nerve supplies branches to the supraspinatus muscle, and a slender *articular* filament to the shoulder-joint ; and it then descends through the great scapular notch to the lower fossa, where it ends in the infraspinatus muscle, furnishing sometimes a second twig to the articulation of the shoulder.

**Varieties.**—The communicating branch to the phrenic nerve has been seen to pass down into the thorax over the subclavian artery, and even over the vein, before joining with the trunk. A second filament to the phrenic, from the sixth nerve, is rarely met with. The posterior thoracic nerve often gets an additional root from the seventh cervical, and Lucas has recorded three instances in which it received a fourth branch or root from the eighth cervical nerve: its highest root from the fifth cervical nerve is frequently united at its origin with the nerve to the rhomboids. The suprascapular nerve is sometimes derived entirely from the fifth cervical nerve.

### BRANCHES BELOW THE CLAVICLE.

The several nerves now to be described are derived from the three great cords of the plexus in the following order.

From the upper or outer cord,—the external of the two anterior thoracic nerves, the musculo-cutaneous, and the outer head of the median.

From the lower or inner cord,—the inner of the two anterior thoracic, the nerve of Wrisberg or small internal cutaneous, the internal cutaneous, the ulnar, and the inner head of the median.

From the posterior cord,—the subscapular nerves, the circumflex, and the musculo-spiral.

If the fasciculi of which the principal nerves are composed be followed through the plexus, they may be traced to those of the spinal nerves which in the subjoined table are named along with each trunk. The higher numbers refer to the cervical nerves, the unit to the dorsal nerve :—

| | | | |
|---|---|---|---|
| Subscapular from . . | 5.6.7.8. | Ulnar . . . . | 8.1. or 7.8.1. |
| Circumflex . . . | | Internal cutaneous . | 8.1. |
| Musculo-spiral. . . | | Small internal cutaneous | |
| External cutaneous . . | 5.6.7. | Anterior thoracic | outer 5.6.7. |
| Median . . . . | 5.6.7.8.1. | | inner 8.1. |

**Anterior thoracic nerves.**—The anterior thoracic nerves, two in number, supply the pectoral muscles.

The *external*, or more superficial branch, arising from the outer cord, crosses inwards over the axillary artery, and, after giving off a branch to join the inner nerve, terminates in the great pectoral muscle.

The *internal*, or deeper branch, springing from the inner cord, comes forwards between the axillary artery and vein, and is joined by the communicating branch from the external nerve, with which it forms a plexiform loop embracing the axillary artery. From this loop offsets proceed to both the small and large pectoral muscles.

**Subscapular nerves.**—The subscapular nerves are usually three in number and supply the muscles forming the posterior wall of the axilla.

The *upper nerve*, the smallest of the three, penetrates the upper part of the subscapularis muscle. This branch is sometimes double.

The *middle* or *long subscapular nerve* is the largest of the three, and descends in company with the subscapular artery to enter the deep surface of the latissimus dorsi muscle.

The *lower subscapular nerve* gives a branch to the subscapularis at its axillary border, and ends in the teres major muscle.

**Varieties.**—The branches to the lower part of the subscapularis and the teres major muscles are sometimes independent offsets of the brachial plexus. The nerve to the teres major is occasionally given off by the commencement of the circumflex nerve.

**Circumflex nerve.**—The circumflex nerve, one of the terminal branches of the posterior cord of the plexus, is placed at first behind the axillary artery, resting on the subscapularis muscle. At the lower border of the latter it turns backwards with the posterior circumflex artery, and appears at the back of the shoulder in the quadrilateral space between the two teres muscles, external to the long head of the triceps, where it divides into branches, which are distributed to the deltoid and teres minor muscles, the integument of the shoulder, and the shoulder-joint.

Fig. 340.

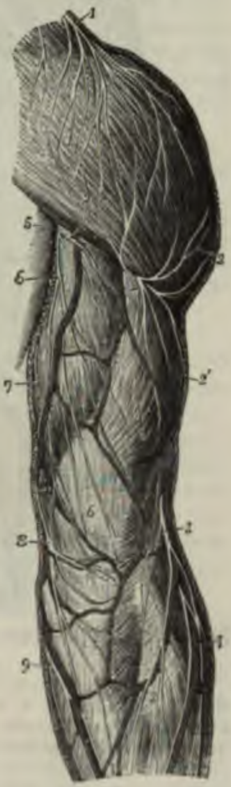

Fig. 340.—Distribution of the posterior cutaneous nerves of the shoulder and arm (after Hirschfeld and Leveillé). $\frac{1}{5}$

1, supra-acromial branches of the cervical plexus descending on the deltoid muscle; 2, ascending and 2′, descending cutaneous branches of the circumflex nerve; 3, inferior external cutaneous of the musculo-spiral nerve; 4, posterior cutaneous branches of the musculo-cutaneous nerve to the forearm; 5, internal cutaneous of the musculo-spiral; 6, intercosto-humeral nerve; 7, nerve of Wrisberg; 8, 9, posterior branches of the internal cutaneous nerve.

(*a*) The *upper branch* winds round the surgical neck of the humerus, extending nearly as far as the anterior border of the deltoid muscle, to which it is distributed. One or two *cutaneous filaments*, penetrating between the muscular fibres, are bent downwards and supply the integument over the lower part of the muscle.

(*b*) The *lower branch* supplies offsets to the back part of the deltoid, and furnishes the nerve to the teres minor, which is remarkable in presenting a gangliform enlargement. It then turns round the posterior border of the deltoid below the middle, and ramifies in the integument, over the lower two-thirds of that muscle, and over the adjacent part of the triceps muscle.

(*c*) An *articular filament* for the shoulder-joint arises near the commencement of the nerve, and enters the capsular ligament below the subscapular muscle.

**Internal cutaneous nerve.**—At its origin from the inner cord of the brachial plexus, this nerve is placed on the inner side of the axillary artery. It becomes cutaneous about the middle of the arm, and, after perforating the fascia, or, in some cases, before doing so, is divided into two parts; one destined for the anterior, the other for the posterior surface of the forearm.

(*a*) The *anterior branch* crosses at the bend of the elbow behind (less frequently over) the median-basilic vein, and distributes filaments in front of the forearm, as far as the wrist; one of these is, in some instances, joined with a cutaneous branch of the ulnar nerve.

(*b*) The *posterior branch* inclines obliquely downwards at the inner side of the basilic vein, and winding to the back of the limb, over the prominence of the internal condyle of the humerus, extends to the lower part of the forearm. Above the elbow this branch is connected with the smaller internal cutaneous nerve (nerve of Wrisberg), and afterwards

Fig. 341.

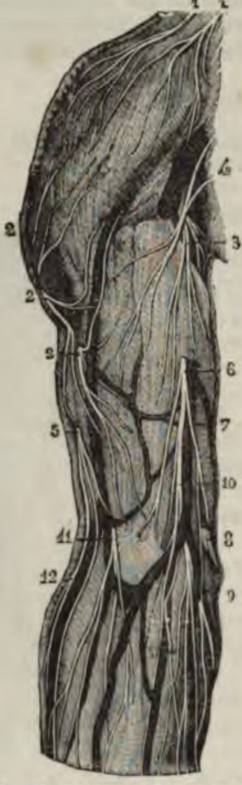

Fig. 342.

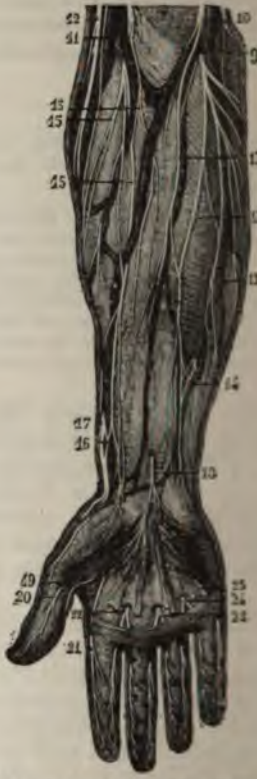

Fig. 341.—Anterior cutaneous nerves of the shoulder and arm (from Sappey, after Hirschfeld and Leveillé). ⅓

1, 1, supraclavicular nerves from the cervical plexus; 2, 2, 2, cutaneous branches of the circumflex nerve; 3, 4, upper branches of the internal cutaneous nerve; 5, upper external cutaneous branch of the musculo-spiral; 6, internal cutaneous nerve piercing the deep fascia; 7, posterior branch; 8, communicating twig with one of the anterior branches; 9, 10, anterior branches of this nerve, some turning round the median-basilic and ulnar veins; 11, musculo-cutaneous nerve descending over the median-cephalic vein; 12, lower external cutaneous branch of the musculo-spiral nerve.

Fig. 342.—Anterior cutaneous nerves of the forearm and hand (from Sappey, after Hirschfeld and Leveillé). ⅓

9, 10, 13, distribution of the anterior branches of the internal cutaneous nerve; 14, union of one of these with a twig of the ulnar nerve; 12, lower external cutaneous branch of the musculo-spiral nerve; 11, 15, distribution of the external cutaneous nerve; 16, union of one of its branches with 17, the radial nerve; 18, palmar cutaneous branch of the median nerve; 19, 20, internal and external digital branches to the thumb from the median nerve; 21, external digital to the index finger; 22, 23, digital branches to the index, middle and ring fingers; 24, 25, digital branches from the ulnar nerve to the ring and little fingers.

**Anterior crural nerve.**—This nerve is the largest branch of the lumbar plexus, and is derived principally from the third and fourth lumbar nerves, but in part also from the second. Emerging from the outer border of the psoas muscle, near its lower part, it descends into the thigh in the groove between that muscle and the iliacus, and, therefore, to the outer side of the femoral blood-vessels. Below Poupart's ligament, the nerve becomes flattened out and divides into two parts, one of which is mainly cutaneous, while the other is distributed for the most part to muscles.

A. *Branches in the trunk.*—The branches given from the anterior crural nerve within the abdomen are few and of small size.

(*a*) The *iliacus* receives three or four small branches, which are directed outwards from the nerve to the fore part of the muscle.

(*b*) The *nerve of the femoral artery* is a small branch which divides into numerous filaments upon the upper part of that vessel. It sometimes arises lower down than usual, in the thigh. It may, on the other hand, be found to take origin above the ordinary position from the third lumbar nerve. Beck and Rauber describe a filament passing from this nerve, in company with the medullary artery, to the femur.

B. *Terminal branches.*—From the principal or terminal divisions of the nerve the remaining branches take their rise as follows:

From the *superficial* or *anterior division* cutaneous branches are given to the fore part of the thigh, and to the inner side of the leg: they are the middle and internal cutaneous nerves. Two muscles, the sartorius and the pectineus, receive their nerves from this group.

From the *deep* or *posterior division* branches proceed to supply the extensor muscle of the knee, and also one cutaneous nerve, the internal saphenous.

(*a*) *Middle cutaneous nerve.*—The middle cutaneous nerve either pierces the fascia lata in two parts about four inches below Poupart's ligament, or as one trunk which soon divides into two branches. These branches descend on the fore part of the thigh to the front and inner side of the patella. After or before the nerve has become subcutaneous, it communicates with the crural branch of the genito-crural nerve, and also with the internal cutaneous.

This nerve, or the outermost of its branches, frequently pierces the upper part of the sartorius muscle.

(*b*) *Internal cutaneous nerve.*—The internal cutaneous nerve gives branches to the skin on the inner side of the thigh, and the upper part of the leg; but the extent to which it reaches varies with the presence or absence of the "occasional cutaneous" branch of the obturator nerve.

Lying beneath the fascia lata, this nerve descends obliquely over the upper part of the femoral artery. It divides either in front of that vessel, or at the inner side, into two branches (one anterior, the other posterior), which pierce the fascia separately. Before dividing, this nerve gives off two or three cutaneous twigs, which accompany the upper part of the long saphenous vein. The highest of these perforates the fascia near the saphenous opening, and reaches down to the middle of the thigh. The others appear beneath the skin lower down by the side of the vein: one, larger than the rest, passes through the fascia about the middle of the thigh, and extends to the knee. In some instances, these small branches spring directly from the anterior crural nerve, and they often communicate with each other.

posterior digital nerves now described are united with twigs directed backwards from the anterior digital nerves of the same fingers.

B. *Branches in the palm.*

(*a*) The *superficial part* of the ulnar nerve supplies a twig to the palmaris brevis muscle and some filaments to the integument, and divides into two *digital branches*. One of these passes to the ulnar side of the little finger; the other is connected in the palm of the hand with a digital branch of the median nerve, and at the cleft between the little and ring fingers, divides into the collateral nerves for these fingers. The terminal disposition of the digital branches on the fingers is the same as that of the median nerve, to be presently described.

(*b*) The *deep part* turns backwards with the deep branch of the ulnar artery between the abductor and flexor brevis minimi digiti muscles, and follows the course of the deep palmar arch across the hand. It supplies the short muscles of the little finger as it passes between them; as it lies over the metacarpal bones, it distributes branches to the interosseous muscles and the inner two lumbricales; and at the outer side of the palm it terminates in offsets to the adductor pollicis, inner head of the flexor brevis pollicis, and the abductor indicis muscles. Rüdinger describes filaments ascending to the wrist, and others descending to the metacarpo-phalangeal articulations.

**Varieties.**—The ulnar nerve sometimes gets an additional root from the seventh cervical nerve, or from the outer cord of the brachial plexus. When the occasional epitrochleo-anconeus muscle (p. 211) is present, it receives a branch from the ulnar nerve in the upper arm (Henle). From the same part of the nerve also small branches have been found entering the inner head of the triceps. In four instances, Gruber has seen the nerve descending in front of the inner condyle instead of behind. Zuckerkandl records cases in which the ulnar nerve slipped forwards over the internal condyle when the elbow was bent (Wiener Jahrbücher, 1880). A communicating branch from the median to the ulnar nerve in the forearm is of frequent occurrence. The ulnar nerve has also been seen furnishing one or two branches to the flexor sublimis digitorum (Turner, G. D. T.).

SUMMARY.—The ulnar nerve gives cutaneous filaments to the lower part of the forearm (to a small extent), and to the hand on its palmar and dorsal aspects. It supplies the following muscles, viz., the ulnar flexor of the carpus, the deep flexor of the fingers (its inner half), the short muscles of the little finger with the palmaris brevis, the interosseous muscles of the hand, the inner two lumbricales, the adductor pollicis and the inner half of the flexor brevis pollicis. Lastly, it contributes to the nervous supply of the joints of the elbow, wrist and hand.

**Median nerve.**—The median nerve arises by two roots or heads, one from the outer, the other from the inner cord of the brachial plexus. Commencing by the union of these roots in front or on the outer side of the axillary artery, the nerve descends in contact with the brachial artery, gradually passing inwards over it, and near the elbow is at the inner side of the vessel. Crossing the bend of the arm, it passes beneath the pronator radii teres, separated by the deep slip of that muscle from the ulnar artery, and continues straight down the front of the forearm, between the flexor sublimis and flexor profundus digitorum muscles. Arrived near the wrist it lies beneath the fascia, between the tendons of the flexor sublimis and that of the flexor carpi radialis. It then enters the palm behind the annular ligament, and rests on the flexor tendons. Somewhat enlarged, and of a slightly reddish colour, it here separates into two parts of nearly equal size. One of these (the external) supplies some of the short muscles of the thumb, and gives digital branches to the thumb and the index finger; the second portion supplies the middle finger, and in part the index and ring fingers.

The median nerve usually gives no branch in the upper arm.

A.—*Branches in the forearm.*

(*a*) *Articular branches.*—These are one or two filaments to the front of the elbow-joint (Rüdinger).

(*b*) *Muscular branches* arise either together or separately in the neighbourhood of the elbow and pass to the pronator teres, flexor carpi radialis, palmaris longus and flexor sublimis digitorum. A second branch to the flexor sublimis is usually given off by the trunk at a lower level in the forearm.

(*c*) *Anterior interosseous nerve.*—This is the longest branch of the median nerve, and it supplies the deeper muscles of the front of the forearm. Leaving the main trunk a little below the elbow, it runs downwards with the artery of the same name on the interosseous membrane to the deep surface of the pronator quadratus muscle, in which it ends. It distributes branches to the flexor longus pollicis and the outer half of the flexor profundus digitorum between which it lies; other filaments are supplied to the interosseous membrane and the bones of the forearm (Rauber, "Ueber die Nerven der Knockenhaut," &c., München, 1868); and from its lower end a twig is continued to the front of the wrist-joint.

(*d*) The *palmar cutaneous branch* arises a variable distance above the wrist, and pierces the fascia of the forearm close to the annular ligament, to terminate in the integument of the palm, where it communicates with the palmar cutaneous branch of the ulnar nerve. Some filaments are distributed over the ball of the thumb, and form communications with twigs of the radial or external cutaneous nerve.

B. *Branches in the hand.*

Fig. 345.

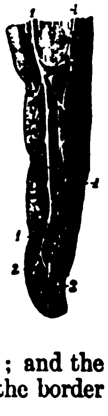

Fig. 345.—Distribution of the digital nerves (from Hirschfeld and Leveillé). ½

1, palmar collateral nerve; 2, its final palmar distribution; 3, its dorsal or ungual distribution, and between these numbers the network of terminal filaments; 4, dorsal collateral nerve; 5, uniting twigs passing between the dorsal and palmar digital nerves.

(*a*) *Branch to muscles of the thumb.*—This short nerve subdivides into branches for the abductor, the opponens, and the outer head of the flexor brevis pollicis muscles.

(*b*) *Digital nerves.*—These are five in number, and belong to the thumb, and the fingers as far as the outer side of the ring-finger. As they approach the clefts between the fingers, they are close to the integument in the intervals between the longitudinal divisions of the palmar fascia.

The *first* and *second* nerves lie along the sides of the thumb; and the former (the outer one) is connected with the radial nerve over the border of the thumb.

The *third*, destined for the radial side of the index finger, gives a branch to the first or most external lumbricalis muscle.

Fig. 348.

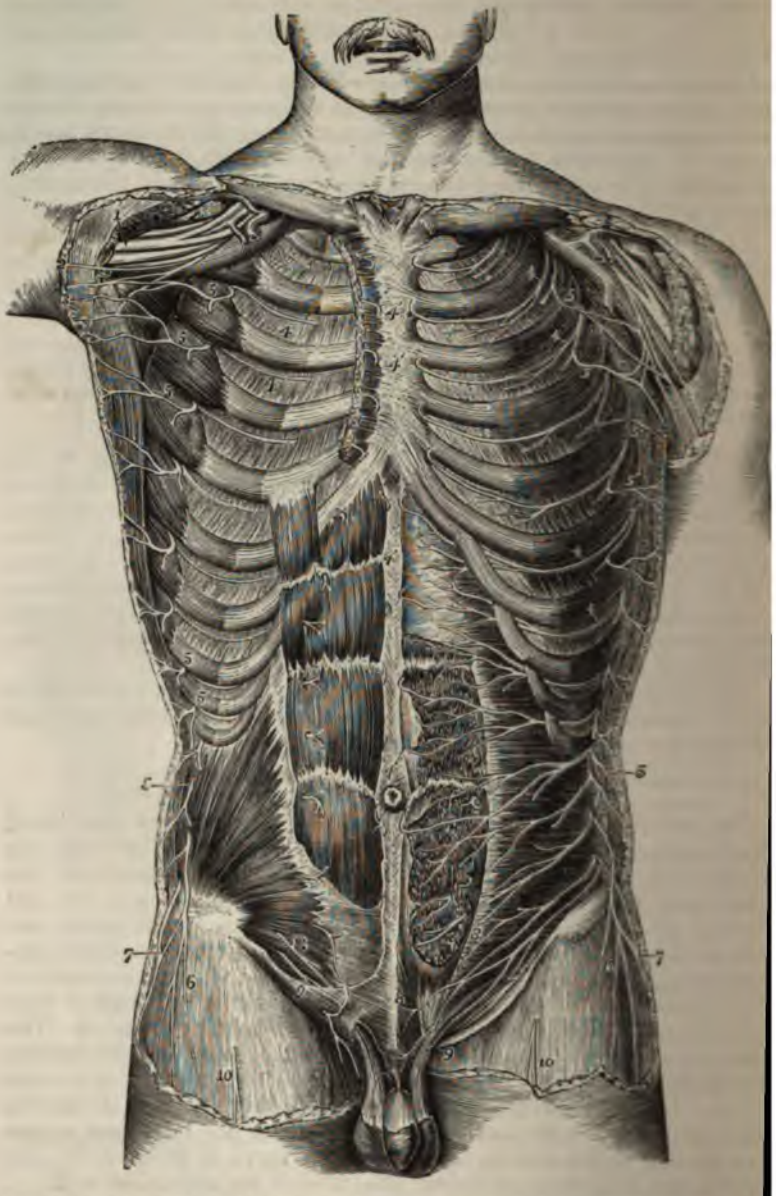

Fig. 348.—View of the anterior divisions of the dorsal and some of the
SPINAL NERVES FROM BEFORE (from Hirschfeld and Leveillé). ¼

The pectoralis major and minor muscles have been removed; on the right side
rectus abdominis and internal oblique muscles are shown, on the left side the
part of the rectus is cut away, and the transversalis is exposed.

1, median and other nerves of the brachial plexus; 2, nerve of Wrisberg; 3, inter humeral ; 4, intercostal nerves continued forwards to 4′, their anterior cutaneous twigs ; 5, lateral cutaneous branches of these nerves ; 6, lateral cutaneous branch of the last dorsal nerve ; 7, iliac branch of the ilio-hypogastric nerve ; 8, hypogastric branch of the same ; 9, ilio-inguinal ; 10, middle cutaneous of the thigh.

the *first intercostal*, a small branch which courses along the first intercostal space, in the manner of the other intercostal nerves, but has usually no lateral cutaneous branch, and may also want the anterior cutaneous.

**Variety.**—The first dorsal nerve frequently receives a connecting twig which passes upwards in front of the neck of the second rib from the second nerve. This branch was found by Cunningham in twenty-seven out of thirty-seven dissections ; it was of variable size, but generally very small, and it sometimes joined only one, in other cases both, of the divisions of the first nerve (Journ. Anat., xi., 539).

### UPPER OR PECTORAL INTERCOSTAL NERVES.

In their course to the fore part of the chest, these nerves accompany the intercostal blood-vessels. After a short space they pass between the internal and external intercostal muscles, supplying them with twigs, as well as the levatores costarum and serratus posticus superior, and, about midway between the vertebræ and the sternum, they give off the lateral cutaneous branches. The nerves, greatly diminished, are now continued forwards amid the fibres of the internal intercostal muscles as far as the costal cartilages, where they come into contact with the pleura. In approaching the sternum, they cross the internal mammary artery and the fibres of the triangularis sterni muscle to which they give filaments. Finally, these nerves pierce the internal intercostal muscle and the greater pectoral, and end in the integument of the breast, receiving the name of the anterior cutaneous nerves of the thorax.

At the side of the chest some of the twigs occasionally cross the inner surface of the ribs, passing from one intercostal space to join the nerve in the interval next below.

The **lateral cutaneous nerves of the thorax** pierce the external intercostal and serratus magnus muscles, in a line a little behind the pectoral border of the axilla. The first intercostal usually gives no lateral branch or only a slender twig to the axilla, but when that of the second nerve is unusually small, it may be supplemented by that of the first. The branch from the second intercostal is named intercosto-humeral, and requires separate description. Each of the remaining lateral cutaneous nerves divides into two branches, which reach the integument at a short distance from each other, and are named anterior and posterior.

The *anterior branches* are continued forwards over the border of the great pectoral muscle. Several reach the mammary gland and the nipple ; and from the lower nerves twigs are supplied to the digitations of the external oblique muscle of the abdomen.

The *posterior branches* turn backwards to the integument over the scapula and the latissimus dorsi muscle. The branch from the third nerve ramifies in the axilla, and a few filaments reach the arm.

The *intercosto-humeral nerve*, the lateral cutaneous branch of the second intercostal nerve, corresponds with the posterior of the two divisions of the succeeding lateral cutaneous branches, the anterior being commonly wanting. It crosses the axillary space to reach the arm, and is connected in the axilla with an offset of the nerve of Wrisberg (p. 609). Penetrating the fascia, it becomes subcutaneous, and first and second, and the greater part of the third, sacral nerves, and is continued into the great sciatic nerve: the lower band, which has a more plexiform arrangement, results from the junction of the smaller

Fig. 354.

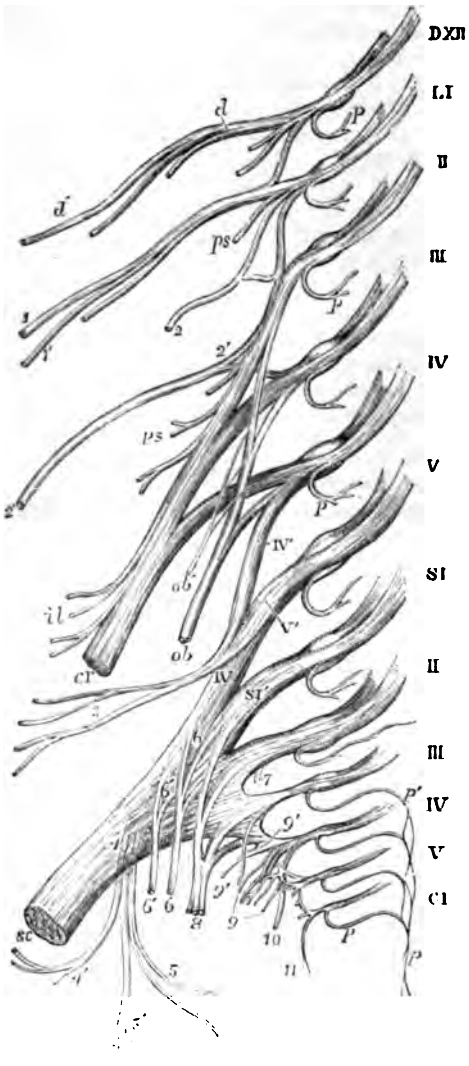

Fig. 354. — DIAGRAMMATIC OUTLINE OF THE LUMBAR AND SACRAL PLEXUSES WITH THE PRINCIPAL NERVES ARISING FROM THEM. (A.T.)

The references to the nerves of the lumbar plexus will be found at p. 622. IV, V, loop from the anterior primary branches of the fourth and fifth lumbar nerves, forming the lumbo-sacral cord; 3, superior gluteal nerve; sc, great sciatic nerve, continued from the sacral plexus; 4, small sciatic nerve, rising from the plexus posteriorly; 4', inferior gluteal nerve; 5, inferior pudendal; 5', posterior cutaneous of the thigh and leg; 6, 6, branch to the obturator internus and gemellus superior; 6', 6', branch to the gemellus inferior, quadratus femoris, and hip-joint; 7, twigs to the pyriformis; 8, pudic nerve; 9, visceral branches; 9', twig to the levator ani; 10, perforating cutaneous nerve; 11, coccygeal branches.

part of the third sacra nerve with the portio of the fourth nerve be longing to the plexu and is prolonged int the pudic nerve. Th lower band is, howeve in some cases joine also by a fasciculus fro the second sacral nerv To the place of unio the nerves proceed i different directions, th of the upper ones bein obliquely downwar while that of the low is nearly horizontal and, as a consequenc of this difference, they diminish in length from the first to the last. Th sacral plexus rests on the anterior surface of the pyriformis muscl opposite the side of the sacrum, and escaping through the great sacro sciatic foramen, ends at the lower border of the pyriformis in the grea sciatic and pudic nerves.

The **lateral cutaneous branch** of the last dorsal nerve, passing through both oblique muscles, is directed downwards over the iliac crest to the integument covering the fore part of the gluteal region, some filaments reaching as far as the great trochanter of the femur.

### LUMBAR NERVES.

The anterior divisions of the lumbar nerves increase in size from the first to the fifth; and all, except the fifth, which passes down to join the sacral nerves, are connected together in loops, so as to form the lumbar plexus. On leaving the intervertebral foramina, the nerves are connected by filaments with the cord of the sympathetic, these filaments being longer than those connected with other spinal nerves, in consequence of the position of the lumbar sympathetic ganglia on the fore part of the bodies of the vertebræ. In the same situation small twigs are furnished to the psoas and quadratus lumborum muscles.

### LUMBAR PLEXUS.

The lumbar plexus is formed by the communications between the anterior primary divisions of the four upper lumbar nerves. It is placed in the substance of the psoas muscle, in front of the transverse processes of the corresponding vertebræ. Above, the plexus is narrow, and is usually connected with the last dorsal nerve by a small offset from that nerve, named dorsi-lumbar; below, it is wider, and is joined to the sacral plexus by means of a branch passing from the fourth lumbar nerve to the fifth.

The arrangement of the plexus may be thus stated. The first nerve gives off the ilio-hypogastric and ilio-inguinal nerves, and sends downwards a communicating branch to the second nerve. The second furnishes the greater part of the genito-crural and external cutaneous nerves, and gives a connecting branch to the third, from which some of the fibres of the anterior crural and obturator nerves are derived. From the third nerve two branches proceed; one of these, the larger, forms part of the anterior crural nerve; the other, a part of the obturator nerve. The fourth nerve gives three branches, two of which serve to complete the obturator and anterior crural nerves, while the third is a connecting branch to the fifth nerve, and enters into the formation of the sacral plexus.

The BRANCHES of the lumbar plexus form two sets, which are distributed, one to the lower part of the wall of the abdomen, the other to the fore part and inner side of the lower limb. In the former set are the ilio-hypogastric and ilio-inguinal nerves, and part of the genito-crural; and to the latter belong the remaining part of the genito-crural nerve, the external cutaneous, the obturator, and the anterior crural nerves.

**Ilio-hypogastric and ilio-inguinal nerves.**—These nerves are the upper two branches from the lumbar plexus; they are both derived from the first lumbar nerve, and have a nearly similar distribution. They become subcutaneous by passing between and through the broad muscles of the abdomen, and end in the integument of the groin and scrotum in the male, and the labium pudendi in the female, as well as in the integument of the gluteal region. The extent of distribution of the one is inversely proportional to that of the other.

Fig. 349.

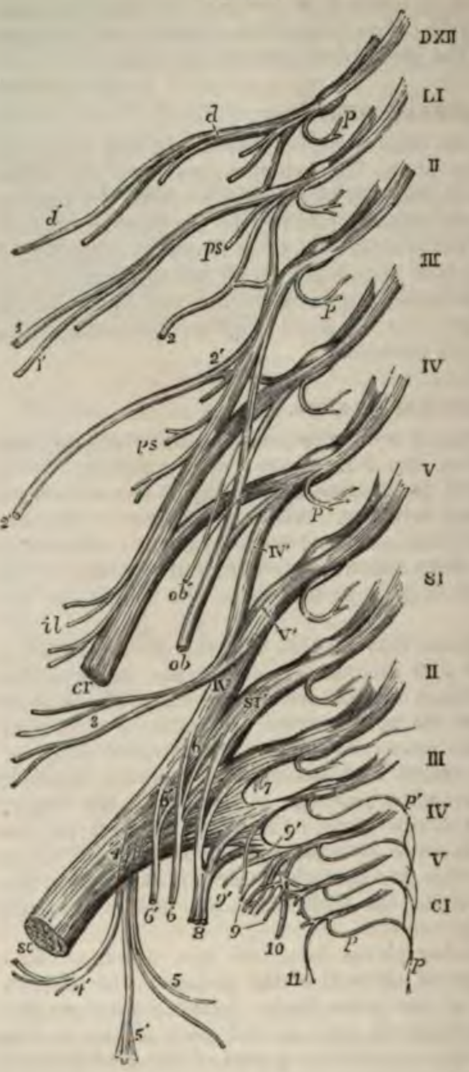

Fig. 349.—Diagra
line of the l
sacral plexuses
principal nerv
from them. (A

DXII, the divi
the last dorsal nerv
the roots of the
nerves; the loops
anterior primary
these nerves togeth
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shown; SI, to V,
sacral and coccygeal
placed on some of
marks the posteri
divisions cut short
plexus formed by t
the posterior bran
third, fourth, and
and the coccygeal
anterior division
dorsal nerve, from
lateral cutaneous br
1, ilio-hypogastric
ilio-inguinal; 2, ge
2', external cutan
thigh; *ps*, branches
muscle; *cr*, ante
nerve; *il*, branch
iliacus; *ob*, obtur
*ob'*, accessory obtu
V', loop from the
fifth lumbar, formin
sacral cord; 3, sup
nerve; *sc*, great s
continued from
plexus; 4, small s
rising from the p
riorly; 4', inferior g
5, inferior pudenda
rior cutaneous of th
leg; 6, 6, branch
rator internus and
perior; 6', 6', bra
gemellus inferior,
femoris and hip-joi
to the pyriformis
nerve; 9, visceral
twig to the levat
perforating cutan
11, coccygeal bran

The **ilio-hypogastric nerve**, emerging from the upper p
psoas muscle at the outer border, runs obliquely over the
lumborum to the iliac crest, and there perforating the transve
of the abdomen, gets between that muscle and the internal o
divides into an iliac and a hypogastric branch.

(*a*) The *iliac branch* pierces the attachment of both obliq
immediately above the iliac crest, and is lost in the integume
gluteal muscles, behind the distribution of the lateral cutane
of the last dorsal nerve.

(*b*) The *hypogastric* or *abdominal branch* passes on between the transversalis and internal oblique muscles, to both of which it supplies twigs, and is connected with the ilio-inguinal nerve near the iliac crest. It then perforates the internal oblique muscle, and, piercing the aponeurosis of the external oblique a little above the external abdominal ring, is distributed to the skin of the abdomen above the pubis.

The iliac branch of this nerve varies in size inversely with the lateral cutaneous branch of the twelfth dorsal, and it is sometimes altogether wanting. The hypogastric branch is not unfrequently joined with the last dorsal nerve between the muscles, near the crest of the ilium.

The **ilio-inguinal nerve,** smaller than the preceding, supplies the integument of the groin. Descending obliquely outwards over the quadratus lumborum, it crosses the fibres of the iliacus muscle, being placed lower down than the ilio-hypogastric: it then perforates the transverse muscle farther forwards than the ilio-hypogastric, and communicates with that nerve between the abdominal muscles. Then piercing the internal oblique muscle, it descends in the inguinal canal, and emerging at the external abdominal ring, is distributed to the skin of the inner part of the groin, as well as to that upon the scrotum and penis in the male, or the labium pudendi in the female, communicating with the inferior pudendal nerve. In its progress this nerve furnishes branches to the internal oblique, transversalis, and pyramidalis (Ellis) muscles.

**Varieties.**—The ilio-inguinal nerve occasionally arises from the loop connecting the first and second lumbar nerves. It is sometimes small, and ends near the iliac crest by joining the ilio-hypogastric nerve; in which case the latter gives off an inguinal branch having a similar course and distribution to the ilio-inguinal nerve, the place of which it supplies.

**Genito-crural nerve.**—The genito-crural nerve belongs partly to the external genital organs and partly to the thigh. It is derived chiefly from the second lumbar nerve, but receives also a few fibres from the connecting cord between that and the first nerve. The nerve descends obliquely through the psoas muscle, and afterwards on the anterior surface of the muscle, towards Poupart's ligament, dividing at a variable height into an internal or genital, and an external or crural branch. It often bifurcates close to its origin from the plexus, in which case its two branches perforate the psoas muscle in different places.

(*a*) The *genital branch* (external spermatic, Schmidt) lies upon or near the external iliac artery, and sends a filament along that vessel; then perforating the transversalis fascia (or passing through the deep abdominal ring) it traverses the inguinal canal with the spermatic cord, and is lost upon the cremaster muscle. In the female it accompanies the round ligament of the uterus.

(*b*) The *crural branch* (lumbo-inguinal nerve, Schmidt) descends upon the psoas muscle beneath Poupart's ligament into the thigh. Immediately below that ligament, and at the outer side of the femoral artery, it pierces the fascia lata, and supplies the skin on the upper part of the thigh, communicating with the middle cutaneous branch of the anterior crural nerve. While it is passing beneath Poupart's ligament, some filaments are prolonged from this nerve on the femoral artery.

**Pudic nerve.**—The pudic nerve is a short plexiform
derived from the lowest part of the sacral plexus, and di
to the perineum and external organs of generation. It
third and fourth, sometimes also the second, sacral nerv
the pelvis between the pyriformis and coccygeus muscles,
forwards over the ischial spine, being placed here on th
the pudic vessels, to the small sacro-sciatic foramen.
arrived at the hinder part of the ischio-rectal fossa, the
dividing into the following three branches, viz., the i
rhoidal nerve, the perineal nerve, and the dorsal nerve
clitoris, according to the sex.

(*a*) The *inferior hæmorrhoidal nerve* is sometimes de
from the sacral plexus ; it inclines inwards towards the
into numerous branches which supply the skin of the hi
perineal space and the external sphincter muscle. Th
branches form communications with the inferior pudenda
perineal nerves.

(*b*) The *perineal nerve* is the largest of the three
pudic nerve. It runs forwards along the outer wall of
fossa, being contained in a special sheath of the obtura
the pudic vessels, and breaks up into superficial and dee

The *superficial perineal nerves* are two in number, exter
The *external* or *posterior*, which is the first to leave the
runs forwards along the outer side of the perineal space
and sometimes gives a branch to the adjacent part of
*internal* or *anterior* branch is larger, and runs forwards n
line, dividing into long slender offsets which are distribut
ment of the scrotum. The two branches communicate
and the external generally receives the connecting fila

external sphincter and levator ani muscles, the transversus perinei, ischio-cavernosus and bulbo-cavernosus. One branch passes inwards through the bulbo-cavernosus muscle, and divides into slender filaments which penetrate the corpus spongiosum and reach the mucous membrane of the urethra.

Fig. 358.

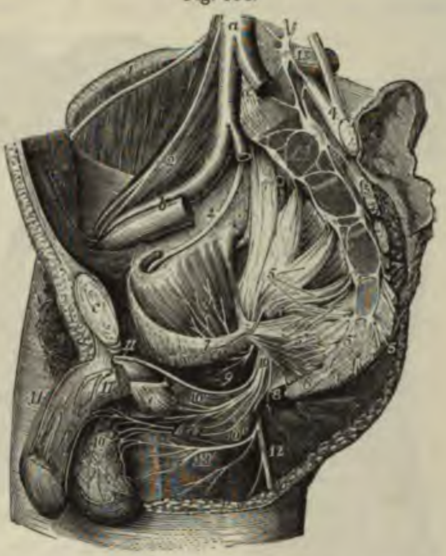


Fig. 358.—RIGHT SIDE OF THE INTERIOR OF THE MALE PELVIS, WITH THE PRINCIPAL NERVES DISPLAYED (after Hirschfeld and Leveillé). ¼

The left wall has been removed as far as the sacrum behind and the symphysis pubis in front; the viscera and the lower part of the right levator ani have been removed; *a*, lower end of the aorta; *a'*, placed on the fifth lumbar vertebra, between the two common iliac arteries, of which the left is cut short; *b*, right external iliac vessels; *c*, symphysis pubis; *d*, the divided pyriformis muscle, close to the left auricular surface of the sacrum; *e*, bulb of the urethra covered by the bulbo-cavernosus muscle; the membranous part of the urethra cut short is seen passing into it; 1, on the crest of the ilium, the external cutaneous nerve of the thigh passing over the iliacus muscle; 2, on the psoas muscle, the genito-crural nerve; 3, obturator nerve; 4, 4, on the lumbo-sacral cords; that of the right side points to the gluteal artery cut short; 4', superior gluteal nerve; 5, on the right sacral plexus, points by four lines to the anterior divisions of the four upper sacral nerves, which, with the lumbo-sacral cord, form the plexus; 5', placed on the fifth piece of the sacrum, points to the fifth sacral nerve; 5'', visceral branches from the third and fourth sacral nerves; 6, placed on the lower part of the coccyx, below the coccygeal nerves; 7, the nerve of the levator ani muscle; 8, inferior hæmorrhoidal nerve; 9, nerve of the obturator internus; 10, pudic nerve; 10', muscular branches of the perineal nerve; 10'', superficial perineal nerves, and on the scrotum the distribution of these nerves and the inferior pudendal nerve; 11, right dorsal nerve of the penis; 11', the nerve on the left crus penis which is cut short; 12, small sciatic nerve; 12', its inferior pudendal branch; 13, on the transverse process of the fifth lumbar vertebra, the lowest lumbar sympathetic ganglion; 14, on the first piece of the sacrum, the upper sacral sympathetic ganglia; between 14 and 6, are seen the remaining ganglia and sympathetic nervous cords, as well as their union with the sacral and coccygeal nerves, and at 6, the lowest ganglion or ganglion impar.

(*c*) The *dorsal nerve of the penis* is the deepest branch of the pudic nerve, and accompanies the pudic artery in its course through the deep perineal fascia (pp. 335 and 457), and between the layers of the suspensory ligament to the dorsum of the penis, along which it passes as far as the glans, where it divides into filaments for the supply of that part. While passing through the deep perineal fascia, it gives fine twigs for the supply of the constrictor urethræ muscle; and on the dorsum of the penis, it is joined by branches of the sympathetic system, and sends outwards numerous offsets to the integument on the upper surface and sides of that organ. Some filaments also penetrate the corpus cavernosum.

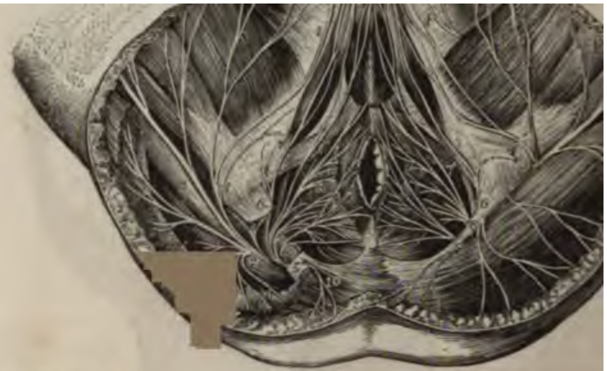


Fig. 359.—Dissection of the perineum of the male to show t
the pudic and other nerves (after Hirschfeld and Leve

On the right side a part of the gluteus maximus muscle and the gre
ment have been removed : 1, great sciatic nerve of the right side
side, inferior gluteal nerve ; 2″, on the left side, gluteal cutaneous b
sciatic; 3, small sciatic nerve in the thigh; 4, 4, inferior pudendal
of this and the superficial perineal nerves on the scrotum ; 5, right pud
branch or dorsal nerve to the penis ; 7, external superficial perineal
superficial perineal branch ; 8, deep or musculo-bulbal branches ; 9, in
nerve ; 10, perforating cutaneous nerve.

Summary.—The pudic nerve supplies the skin and
perineum, the penis, and part of the scrotum in the
clitoris, labia, and other corresponding parts in the f
municates with the inferior pudendal branch of the sma

**Great sciatic nerve.**—The great sciatic nerve (ne
major), the largest nerve in the body, supplies the mus
of the thigh, and by the branches continued from it gi

for some distance in its substance. Lower down it rests on the adductor magnus, and is covered behind by the long head of the biceps muscle.

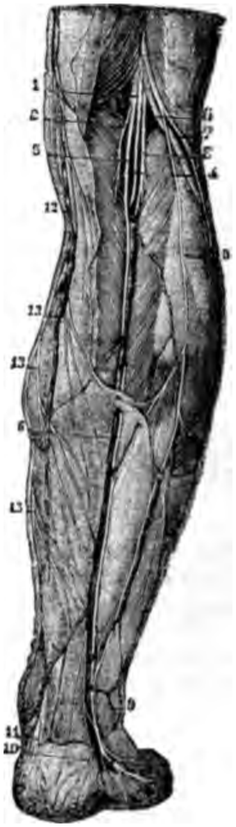
*Branches.*—In its course downwards, the great sciatic nerve supplies offsets to the hamstring muscles, viz., the semitendinosus, two heads of the biceps, and semimembranosus. A branch is likewise given to the inner part of the adductor magnus.

**Varieties.**—The bifurcation of the sciatic nerve may take place at any point intermediate between the sacral plexus and the lower part of the thigh; and, occasionally, it is found to occur even within the pelvis, a portion of the pyriformis muscle being interposed between the two great divisions of the nerve.

Fig. 360.—Posterior cutaneous nerves of the leg (from Sappey, after Hirschfeld and Leveillé).

1, internal popliteal nerve; 2, branch to the inner head of the gastrocnemius muscle; 3, 4, branches to the outer head and plantaris; 5, tibial communicating nerve; 6, external popliteal nerve; 7, cutaneous branch; 8, peroneal communicating branch, descending to unite with that from the internal popliteal in 9, the external saphenous nerve; 10, calcaneal branch from this nerve; 11, calcaneal and plantar cutaneous branches from the posterior tibial nerve; 12, internal saphenous nerve; 13, posterior branches of this nerve.

Fig. 360.



**Internal popliteal nerve.**—The internal popliteal, the larger of the two divisions of the great sciatic nerve, following the same direction as the parent trunk, continues along the middle of the popliteal space to the lower border of the popliteus muscle, beyond which point the continuation of the trunk receives the name of *posterior tibial.* The internal popliteal nerve lies at first at a considerable distance from the popliteal artery, at the outer side and nearer to the surface; but, from the knee-joint downwards, the nerve, continuing a straight course, is close behind the artery, and then crosses it rather to the inner side.

*Branches.*—The internal popliteal nerve supplies branches to the knee-joint and to the muscles of the calf of the leg, and also part of a cutaneous branch, the external or short saphenous nerve.

(*a*) The *articular branches* are given off from the upper part of the popliteal trunk, and are generally three in number; two of them accompany the upper and lower articular arteries of the inner side of the knee-joint, the third follows the middle or azygos artery. These nerves pierce the ligamentous tissue of the joint. The upper one is often wanting.

(*b*) The *muscular branches* arise from the nerve while it is contained in the popliteal space. They include two nerves to the gastrocnemius—one to each head of the muscle; a small nerve to the plantaris, derived either from the branch to the outer head of the gastrocnemius, or dir from the main trunk; a considerable branch to the soleus, which en the muscle on its posterior aspect, close to the upper border; and a n to the popliteus. The last branch arises somewhat lower down, an more deeply placed, than the others; it descends on the outer side of popliteal vessels, and, after having given off one filament to the tibia another to the interosseous membrane, turns beneath the lower bord the muscle, which it penetrates on the deep or anterior surface.

(c) The *cutaneous branch*.—*External* or *short saphenous nerve*.— cutaneous branch of the internal popliteal nerve (*tibial communicat nerve*) descends along the leg, in the furrow between the heads of gastrocnemius muscle, to about midway between the knee and the f Here it perforates the fascia, and a little lower down is usually join a branch from the external popliteal nerve (peroneal communicati After receiving this communicating branch, the external saphen nerve descends beneath the integument near the outer side of the te Achillis in company with the short saphenous vein, and turns forwa beneath the external malleolus to end in the skin on the outer sid the foot and little toe. On the dorsum of the foot this nerve commu cates with the musculo-cutaneous nerve.

**Varieties.**—In many cases the external saphenous nerve supplies the e side of the fourth toe, as well as the little toe. The union between the t communicating nerve and the branch of the external popliteal nerve occur some cases higher than usual, occasionally even at or close to the popliteal sp It sometimes happens that the communication between the nerves is altog wanting; in which case the cutaneous nerve to the foot is generally conti from the branch of the internal popliteal nerve.

**Posterior tibial nerve.**—The internal popliteal nerve receives name of posterior tibial at the lower margin of the popliteus It passes down the leg with the posterior tibial artery, lying first a distance on the inner side of the vessel and afterwards on the side, the artery inclining inwards from its origin while the nerve ta a straighter course. In the interval between the inner malleolus the heel, it divides into the two *plantar nerves* (*internal* and The posterior tibial nerve, like the accompanying vessels, is first by the muscles of the calf of the leg, afterwards only by the ment and fascia, and it rests upon the deep-seated muscles.

*Branches*.—The deep muscles on the back of the leg, the integum of the sole of the foot, and the ankle-joint receive branches fro posterior tibial nerve in its course along the leg.

(a) The *muscular branches* emanate from the upper part of either separately or by a common trunk: one is distributed to the deep muscles, viz., the tibialis posticus, the flexor longus digit and the flexor longus hallucis; and a second nerve is furnished soleus, piercing the deep surface of the muscle. The branch which plies the flexor of the great toe runs along the peroneal artery entering the muscle, and gives off a twig to the fibula.

(b) A *calcaneo-plantar cutaneous branch* is furnished posterior tibial nerve in the lower part of the leg; it perf internal annular ligament, and ramifies in the integument at side of the hinder part of the sole, and over the heel.

(c) One or two *articular filaments* pass from the post nerve close above its division to the inner side of the ankle-joint (Rüdinger).

**Internal plantar nerve.**—The internal plantar, the larger of the two nerves to the sole of the foot into which the posterior tibial divides, accompanies the internal or smaller plantar artery, and supplies nerves to both sides of the inner three toes, and to one side of the fourth. From the point at which it separates from the posterior tibial nerve, it is directed forwards under cover of the first part of the abductor of the great toe; then passing between that muscle and the short flexor of the toes, it gives off the internal collateral branch for the great toe, and divides opposite the middle of the foot into three digital branches. The outermost of these branches communicates with the external plantar nerve. The distribution of this nerve in the foot closely resembles that of the median nerve in the hand.

*Branches.*—(*a*) *Muscular branches* are supplied to the abductor hallucis and flexor brevis digitorum.

(*b*) Small *plantar cutaneous branches* perforate the plantar fascia to ramify in the integument of the sole of the foot.

(*c*) The *digital branches* are named numerically from within outwards: the outer three pass from under cover of the plantar fascia near the clefts between the toes. The first or innermost branch continues single, but the other three bifurcate to supply the adjacent sides of two toes. They are distributed as follows :—

The *first* digital branch is destined for the inner side of the great toe; it becomes subcutaneous farther back than the others, and sends off a branch to the flexor brevis hallucis muscle.

The *second* branch, having reached the interval between the first and second metatarsal bones, furnishes a small twig to the first lumbricalis muscle, and bifurcates behind the cleft between the great toe and the second to supply their contiguous sides.

The *third* digital branch, corresponding with the second interosseous space, gives a slender filament to the second lumbricalis muscle, and divides in a manner similar to that of the second branch into two offsets for the sides of the second and third toes.

The *fourth* digital branch, distributed to the adjacent sides of the third and fourth toes, receives a communicating branch from the external plantar nerve.

Along the sides of the toes, cutaneous and articular filaments are given from these digital nerves; and, opposite the ungual phalanx, each sends a dorsal branch to the pulp beneath the nail, and then runs on to the ball of the toe, where it is distributed like the nerves of the fingers.

**External plantar nerve.**—The external plantar nerve completes the supply of digital nerves to the toes, furnishing branches to the little toe and half the fourth; it also gives a deep branch of considerable size, which is distributed to several of the short muscles in the sole of the foot. There is thus a great resemblance between the distribution of this nerve in the foot and that of the ulnar nerve in the hand.

The external plantar nerve runs obliquely forwards towards the outer side of the foot, along with the external plantar artery, between the flexor brevis digitorum and the flexor accessorius, as far as the interval between the former muscle and the abductor of the little toe. Here it divides into a superficial and a deep branch, having previously furnishe offsets to the flexor accessorius and the abductor minimi digiti.

(*a*) The *superficial portion* separates into two *digital branches*, whic have the same general arrangement as the digital branches of the interna plantar nerve. The outermost of these is undivided, and runs along th outer side of the little toe : it is smaller than the other, and pierces th plantar fascia farther back. The short flexor muscle of the little toe, an sometimes one or both of the interosseous muscles of the fourth spac, receive branches from this nerve.

Fig. 361.

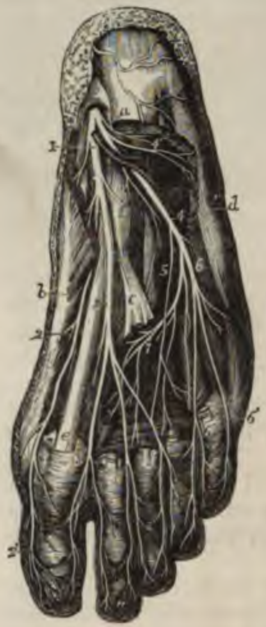


Fig. 361.—SUPERFICIAL AND DEEP DISTRIBUTION O THE PLANTAR NERVES (after Hirschfeld and L veillé, slightly modified). (A. T.) ½

The flexor brevis digitorum, the abductor hallucis an abductor minimi digiti, a part of the tendons of th flexor longus digitorum, together with the lumbrical muscles, have been removed so as to bring into vie the transversus and interosseous muscles in th middle of the foot.

*a*, upon the posterior extremity of the flexor bre digitorum, near which, descending over the heel, ar seen ramifications of the calcaneal branch of th posterior tibial nerve ; *b*, abductor hallucis ; *c*, tendo of the flexor longus digitorum, divided close to th place where it is joined by the flexor accessorius ; d abductor minimi digiti ; *e*, tendon of the flexor longu hallucis between the two portions of the flexor brev hallucis ; 1, internal plantar nerve giving twigs t the abductor hallucis, and 1′, a branch to the flex brevis digitorum, cut short ; 2, inner branch of th internal plantar nerve, giving branches to the flex brevis hallucis, and forming 2′, the internal collater nerve of the great toe ; 3, continuation of the interna plantar nerve, dividing into three branches, whic form, 3′, 3′, 3′, the plantar digital nerves of the fir and second, second and third, and third and fourt toes ; 4, external plantar nerve ; 4′, its branch to th abductor minimi digiti ; 5, twig of union betwee the plantar nerves ; 6, superficial branch of the e ternal plantar nerve, dividing into 6′, 6′, the collater digital nerves of the fourth and fifth toes and th external nerve of the fifth ; 7, deep branch of th external plantar nerve.

The larger digital branch communicates with an offset from th internal plantar nerve, and bifurcates near the cleft between the fourt and fifth toes to supply one side of each.

(*b*) The *deep* or *muscular part* of the external plantar nerve dips int the sole of the foot with the external plantar artery, under cover of th tendons of the flexor muscles and the accessorius, and terminates i numerous branches for the following muscles :—all the interosseou (dorsal and plantar) except occasionally one or both of those in the fourt space, the two outer lumbricales, the adductor hallucis and the trans versus pedis.

SUMMARY OF THE INTERNAL POPLITEAL NERVE.—This nerve sup plies all the muscles of the back of the leg and sole of the foot, and th integument of the plantar aspect of the toes, the sole of the foot, and in part that of the lower half of the back of the leg.

**External popliteal** or **peroneal nerve**.—This nerve descend

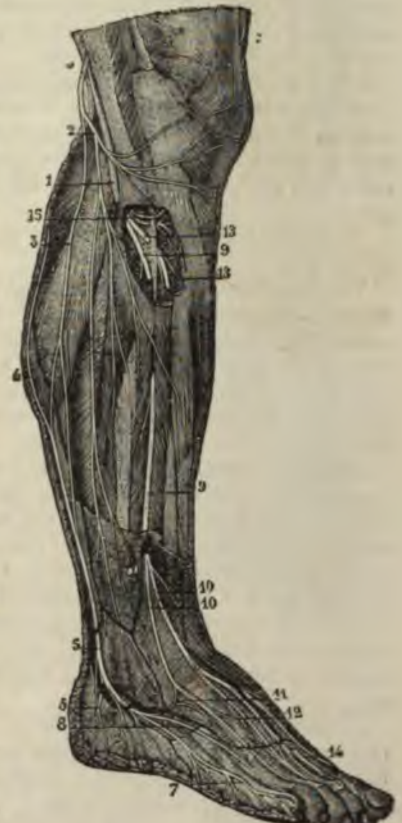
long the outer side of the popliteal space, lying close to the
:le. Continuing downwards over the outer part of the gas-
muscle (between it and the biceps) and below the head of
the nerve turns round that bone, passing between it and the
ngus muscle, and then divides into the *anterior tibial* and
*-cutaneous nerves.*

:s.—Some articular and cutaneous branches are derived from
l popliteal nerve before its final division.

*articular branches* are conducted to the outer side of the cap-
ent of the knee-joint by the upper and lower articular
that side. They sometimes arise together, and the upper
nally springs from the great sciatic nerve before the

e place of division of the external popliteal nerve, a branch
*recurrent articular nerve* ascends through the tibialis anticus

Fig. 362.



TANEOUS NERVES OF THE
OF THE LEG AND FOOT
ey, after Hirschfeld and
½

l popliteal nerve; 2, its
ich; 3, peroneal communi-
which unites with 4, the
icating, in 5, the external
re; 6, calcaneal branch of
phenous; 7, external dorsal
to the fifth toe; 8, dorsal
of the fourth and fifth toes;
:utaneous nerve; 10, 10, its
11, union with the external
2, communication between
ner branches; 13, anterior
hown by the removal of a
cles; 14, its inner terminal
ing in the space between
econd toes, where it gives
dorsal digital branches to
sides; 15, recurrent ar-

nterior tibial recur-
; its fibres terminate
that muscle, but one
ments may reach the
the knee-joint.

*cutaneous branches,*
o in number, supply
the back part and
f the leg.

*eal* or *fibular commu-*
*anch,* which usually
hort saphenous nerve
iddle of the back of the
rgest of these nerves.
stances, it continues as a separate branch, and its cutaneous
ach down to the heel or on to the outer side of the foot.

Another cutaneous branch, often arising in conjunction wi foregoing, extends along the outer side of the leg to the middle o part, sending offsets both backwards and forwards.

**Musculo-cutaneous nerve.**—The musculo-cutaneous ner scends between the peronei muscles and the long extensor of tl and reaches the surface by perforating the fascia in the low of the leg on the anterior aspect. It then divides into two br distinguished as external and internal, which proceed to the toes two branches sometimes perforate the fascia at different spots.

*Branches.*—(*a*) *Muscular branches* are given to the peroneus and peroneus brevis.

(*b*) *Cutaneous branches* given off near the primary divisi distributed to the lower part of the leg.

(*c*) The *internal branch* of the musculo-cutaneous nerve, p forwards along the dorsum of the foot, furnishes one branch to th side of the great toe, and another to the contiguous sides of the and third toes. It also gives offsets which extend over the inner and side of the foot. This nerve communicates with the long sapl nerve on the inner side of the foot, and with the anterior tibial between the first and second toes.

(*d*) The *external branch*, smaller than the internal, descends on foot towards the fourth toe, which, together with the contin borders of the third and fifth toes, it supplies with branches. Cuta nerves, derived from this branch, spread over the outer ankle an outer side of the foot, where they are connected with the short saph nerve.

The dorsal digital nerves are continued on to the last pha of the toes.

The number of toes supplied by each of the two divisions o musculo-cutaneous nerve is liable to vary; together, these n commonly supply all the toes on the dorsal aspect, excepting the side of the little toe, which receives a branch from the short saph nerve, and the adjacent sides of the great toe and the second t which the anterior tibial nerve is distributed: with this latter b however, it generally communicates.

**Anterior tibial nerve.**—The anterior tibial nerve, com ing between the fibula and the peroneus longus, inclines obl beneath the long extensor of the toes to the fore part of the osseous membrane, and there comes into contact with the a tibial vessels: with these vessels it descends to the front of the joint, where it divides into an external and an internal branch. Th reaches the anterior tibial artery about the junction of the upp the second fourth of the leg, and is thence placed in front vessels as far as the ankle, at which spot it is usually on the side.

*Branches.*—(*a*) *Muscular branches.*—In its course along the anterior tibial nerve gives offsets to the adjacent muscles, nam tibialis anticus, the extensor longus digitorum, the extensor p hallucis, and the peroneus tertius.

(*b*) An *articular filament* for the ankle-joint arises from the low of the nerve.

(*c*) The *external branch* of the anterior tibial nerve turns o over the tarsus beneath the short extensor of the toes; and, become enlarged (like the posterior interosseous nerve on the wrist) breaks up into branches which supply the short extensor muscle, and the articulations of the foot.

(*d*) The *internal branch*, continuing onwards in the direction of the anterior tibial nerve, accompanies the dorsal artery of the foot to the first interosseous space, and ends in two branches, which supply the integument on the neighbouring sides of the great toe and the second toe on their dorsal aspect. It communicates with the internal division of the musculo-cutaneous nerve.

From the internal branch one, and from the external two or three, slender *interosseous branches* are sent forwards over the intermetatarsal spaces to the metatarso-phalangeal articulations. The second and sometimes the first of these nerves give twigs to the dorsal interosseous muscles upon which they lie. (Rüdinger; Cunningham, Journ. Anat., xiii., 398.)

Fig. 363.

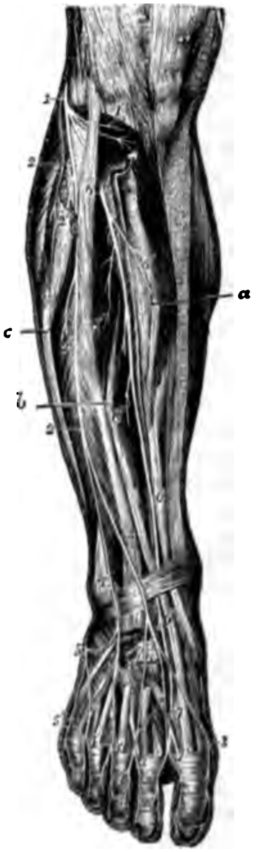


**Fig.** 363.—Distribution of the branches of the external popliteal nerve on the front of the leg and dorsum of the foot (after Hirschfeld and Leveillé). ⅓

The upper part of the peroneus longus muscle has been removed, the tibialis anticus, the long extensor of the great toe and the peroneus longus are drawn apart in the leg by hooks marked *a*, *b*, and *c*, and the tendons of the extensor muscles have been removed on the dorsum of the foot : 1, external popliteal or peroneal nerve, winding round the outer part of the fibula ; 1′, its recurrent articular branches exposed by the dissection of the upper part of the tibialis anticus muscle ; 2, 2, musculo-cutaneous nerve ; 2′, 2′, twigs to the long and short peroneal muscles ; 3, 3′, internal branch of the musculo-cutaneous nerve ; 4, 4′, 4′, its external branch ; 5, external saphenous nerve, uniting at two places with the outer branch of the musculo-cutaneous ; 5′, its branch to the outer side of the fifth toe ; 6, placed on the upper part of the extensor longus digitorum, marks the anterior tibial nerve passing beneath the muscle ; 6, placed farther down on the tendon of the tibialis anticus, points to the nerve as it lies in front of the anterior tibial artery ; 6′, 6′, its muscular branches in the leg ; 6″, on the tendon of the extensor proprius hallucis, points to the anterior tibial nerve after it has passed into the foot behind that tendon ; 7, its inner branch, uniting with a twig of the musculo-cutaneous, and giving the dorsal digital nerves to the adjacent sides of the first and second toes ; 8, distribution of its outer branch to the extensor brevis digitorum and tarsal articulations.

Summary of the external popliteal nerve.—This nerve supplies, besides articular branches to the knee, ankle, and foot, the peronei muscles and the extensor muscles of the foot, also the integument of the front of the leg and dorsum of the foot. It gives the peroneal communicating branch to the short saphenous nerve, and communicates with the long saphenous nerve.

occipital protuberance there is also distributed the
posterior division of the third spinal nerve ; and in f
the great occipital nerve is a space supplied by an
spinal nerves, viz., the back of the pinna of the ear
integument behind, and that in front over the paroti
supplied by the great auricular nerve ; while betwee
nerve and the great occipital the small occipital nerv
auricular branch of the pneumo-gastric nerve also is
back of the ear.

**2. In the trunk.**—The *posterior divisions of the s*
an area extending on the back from the vertex of the s
This area is narrow in the neck ; it is expanded in
extending over the back of the scapula ; and on th
tribution of the lumbar nerves reaches to the great tr

The *area supplied by the cervical plexus*, besides ext
already mentioned, on the lateral part of the skull,
front and sides of the neck, and the upper part of
breast.

The *area of the anterior divisions of the dorsal and*
meets superiorly with that of the cervical plexus, a
that of the posterior divisions of the dorsal and lumb
down over the haunch and along by the outer part of
and includes part of the scrotum and a small portion
of the thigh internal to the saphenous opening.

The *perineum* and *penis* are supplied by the
*scrotum* by branches of the pudic, inferior pudenda
nerves.

**3. In the upper limb.**—The *shoulder*, supplied
cervical plexus, receives its cutaneous nerves inferi
insertion of the deltoid, from the circumflex nerve.

The *arm* internally is supplied by the intercosto-
the nerve of Wrisberg. The inner and anterior par

supplying about three fingers and a half or less, and the ulnar one and a half or more.

On the *front of the hand*, the median nerve supplies three fingers and a half, and the ulnar one and a half. In the *palm* is a branch of the median, and also a branch of the ulnar, given off above the wrist. On the *ball of the thumb* are branches of the musculo-cutaneous, median, and radial nerves.

**4. In the lower limb.**—The *buttock* is supplied from above by the cutaneous branches of the posterior divisions of the lumbar nerves, with the ilio-hypogastric and lateral branch of the last dorsal nerves; internally by the posterior divisions of the sacral nerves; externally by the posterior branch of the external cutaneous nerve proceeding from the front; and inferiorly by the perforating cutaneous nerve and branches of the small sciatic nerve proceeding from below.

The *thigh* is supplied externally by the external cutaneous nerve from the lumbar plexus; posteriorly, and in the upper half of its inner aspect, by the small sciatic; anteriorly, and in the lower half of the inner aspect, by the middle and internal cutaneous of the anterior crural, the latter being frequently assisted by the obturator nerve.

The *leg* is supplied posteriorly by the small sciatic and short saphenous nerves; internally by the long saphenous and branches of the internal cutaneous of the thigh (or obturator); and outside and in front by cutaneous branches of the external popliteal nerve and by its musculo-cutaneous branch.

On the *dorsum of the foot* are the branches of the musculo-cutaneous, supplying all the toes with the exception of the adjacent sides of the first and second, which are supplied by the anterior tibial, and the outer side of the little toe, which, with the outer margin of the foot, is supplied by the short saphenous nerve. The long saphenous is the cutaneous nerve of the inner side of the foot.

The *sole of the foot* is supplied by the plantar nerves. The internal plantar nerve gives branches to three toes and a half; the external to the remaining one toe and a half.

## SYNOPSIS OF THE MUSCULAR DISTRIBUTION OF THE CEREBRO-SPINAL NERVES.

**1. To muscles of the head and fore part of the neck.**—The *muscles of the orbit* are mostly supplied by the third cranial nerve—the superior division of that nerve being distributed to the levator palpebræ and the superior rectus muscles; and the inferior division to the inferior and internal recti and the inferior oblique. The superior oblique muscle is supplied by the fourth nerve, the external rectus by the sixth; while the tensor tarsi has no special nerve apart from those of the orbicularis palpebrarum, which are derived from the facial.

The *superficial muscles of the face and scalp*, which are associated in their action as a group of muscles of expression, together with the buccinator muscle, are supplied by the seventh cranial nerve; the retrahens auriculam and occipitalis muscles being supplied by its posterior auricular branch.

The *deep muscles of the face* employed in mastication, viz., the temporal, masseter, and two pterygoid muscles, are supplied by the inferior maxillary division of the fifth cranial nerve.

*Muscles above the hyoid bone.*—The mylo-hyoid muscle and ante belly of the digastric are supplied by a special branch of the infer maxillary division of the fifth cranial nerve; the posterior belly of t digastric muscle and the stylo-hyoid are supplied by branches of t facial. The genio-hyoid and the muscles of the tongue receive th nervous supply from the hypoglossal nerve.

The *muscles ascending to the hyoid bone and larynx*, viz., the ster hyoid, omo-hyoid, and sterno-thyroid, are supplied from the descendi branch of the hypoglossal nerve and its loop with the cervical plex while the thyro-hyoid muscle receives a separate twig from the twel nerve.

The *larynx, pharynx, and soft palate.*—The crico-thyroid muscle supplied by the external laryngeal branch of the pneumo-gastric ner and the other intrinsic muscles of the larynx by the recurrent larynge The muscles of the pharynx are supplied principally by the pharyng branch of the pneumo-gastric; the stylo-pharyngeus, however, is su plied by the glosso-pharyngeal nerve. Of the muscles of the soft pal unconnected with the tongue or pharynx, the tensor palati receives nerve from the otic ganglion (which also supplies the tensor tympani the levator palati gets a twig from the posterior palatine branch of t spheno-palatine ganglion (Meckel), and is therefore innervated by t facial, while the azygos uvulæ is probably supplied from the same sour

**2. To muscles belonging exclusively to the trunk, and musc ascending to the skull.**—All those *muscles of the back* which act up the spine and head, viz., the splenius, complexus, erector spinæ, and t muscles more deeply placed, receive their supply from the posteri divisions of the spinal nerves.

The *sterno-mastoid* is supplied by the spinal accessory nerve and a tw of the cervical plexus coming from the second cervical nerve.

The *rectus capitis anticus major* and *minor* are supplied by twigs fr the upper cervical nerves; the *longus colli* and *scaleni* muscles by twi from nearly all the cervical nerves.

The *muscles of the chest-wall*, viz., the intercostals, subcostals, levato costarum, serrati postici, and triangularis sterni, are supplied by t intercostal nerves.

The *obliqui, transversalis*, and *rectus* of the abdomen are supplied the lower intercostal nerves; and the oblique and transverse musc also get branches from the ilio-inguinal and ilio-hypogastric nerves. T *cremaster* muscle is supplied by the genital branch of the genito-cru nerve.

The *quadratus lumborum* (like the psoas) receives small branches fr the lumbar nerves before they form the plexus.

The *diaphragm* receives the phrenic nerves from the fourth and fi cervical nerves, branches from the lower intercostal nerves (Luschk and likewise sympathetic filaments from the plexuses round the phre arteries.

The *muscles of the urethra and penis* are supplied by the pudic nerv the *levator and sphincter ani* by the pudic and the fourth sacral nerve and the *coccygeus* muscle by the fourth and fifth sacral nerves.

**3. To muscles attaching the upper limb to the trunk.**—T *trapezius* and the *cleido-mastoid* receive the distribution of the *spin accessory* nerve, and, in union with it, filaments from the cervical plexu The *latissimus dorsi* receives the long subscapular nerve.

The *rhomboidei* are supplied by a special branch from the anterior division of the fifth cervical nerve.

The *levator anguli scapulæ* is supplied by branches from the anterior divisions of the third and fourth cervical nerves, and partly also by the branch to the rhomboid muscles.

The *serratus magnus* has a special nerve, the posterior thoracic, derived from the fifth and sixth, sometimes also the seventh, cervical nerves.

The *subclavius* receives a special branch from the place of union of the fifth and sixth cervical nerves.

The *pectorales* are supplied by the anterior thoracic branches of the brachial plexus, the larger muscle receiving filaments from both these nerves, and the smaller from the inner only.

**4. To muscles of the upper limb.**—*Muscles of the shoulder.*—The supraspinatus and infraspinatus are supplied by the suprascapular nerve; the subscapularis by the upper and lower subscapular nerves; the teres major by the lower subscapular; and the deltoid and teres minor by the circumflex nerve.

*Posterior muscles of the arm and forearm.*—The triceps, anconeus supinator longus, and extensor carpi radialis longior are supplied by direct branches of the musculo-spiral nerve; while the extensor carpi radialis brevior and the other extensor muscles in the forearm receive their branches from the posterior interosseous division of that nerve.

*Anterior muscles of the arm and forearm.*—The coraco-brachialis, biceps, and brachialis anticus are supplied by the musculo-cutaneous nerve; the brachialis anticus likewise frequently receives a twig from the musculo-spiral nerve. The muscles of the front of the forearm are supplied by the median nerve, with the exception of the flexor carpi ulnaris and the inner half of the flexor profundus digitorum, which are supplied by the ulnar nerve.

*Muscles of the hand.*—The abductor and opponens pollicis, the outer half of the flexor brevis pollicis, and the two outer lumbricales muscles, are supplied by the median nerve: all the other muscles receive their nerves from the ulnar.

**5. To muscles of the lower limb.**—*Posterior muscles of the hip and thigh.*—The gluteus maximus is supplied by the inferior gluteal nerve; the gluteus medius and minimus, together with the tensor vaginæ femoris, by the superior gluteal nerve. The pyriformis, gemelli, obturator internus, and quadratus femoris receive special branches from the sacral plexus. The hamstring muscles are supplied by branches from the great sciatic nerve.

*Anterior and internal muscles of the thigh.*—The psoas muscle is supplied by separate twigs from the lumbar nerves. The iliacus, quadriceps extensor femoris, sartorius and pectineus are supplied by the anterior crural nerve. The adductor muscles and the obturator externus are supplied by the obturator nerve, but the adductor magnus likewise receives a branch from the great sciatic.

*Anterior muscles of the leg and foot.*—The muscles in front of the leg, together with the extensor brevis digitorum, are supplied by the anterior tibial nerve.

The *peroneus longus* and *brevis* are supplied by the musculo-cutaneous nerve.

*Posterior muscles of the leg.*—The gastrocnemius, plantaris, sole
and popliteus are supplied by branches from the internal poplite
nerve ; the long deep muscles, viz., the flexor longus digitorum, flex
longus hallucis, and tibialis posticus, derive their nerves from t
posterior tibial.

*Plantar muscles.*—The flexor brevis digitorum, the abductor and flex
brevis hallucis, and the inner two lumbricales, are supplied by the intern
plantar nerve ; all the others, including the flexor accessorius and inte
osseous muscles, are supplied by the external plantar nerve.

## SYMPATHETIC NERVES.

The nerves of the sympathetic system are distributed in general to
the internal viscera, and to the coats of the blood-vessels. Some orga
however, receive nerves also from the cerebro-spinal system, as the lun
the heart, and the upper and lower parts of the alimentary canal ; and
is probable that those viscera which are not supplied directly in this w
receive fibres derived originally from cerebro-spinal nerves through the
sympathetic plexuses.

This division of the nervous system consists of a somewhat complicat
collection of ganglia, cords and plexuses, the parts of which may, for co
venience, be classified in two groups, viz., the principal gangliated cord
and the great prevertebral plexuses with the nerves proceeding fr
them. The ganglia of union with cranial nerves, viz., the ophthalmi
spheno-palatine, otic and submaxillary ganglia, which are sometim
regarded as constituting a third division of the sympathetic system, ha
already been described in connection with the fifth nerve.

The **great gangliated cords** are two in number, and each consis
of a series of ganglia united by short intervening cords, sometim
double. These gangliated cords are placed symmetrically, partly
front, and partly on the side, of the vertebral column, extending fr
the base of the skull to the coccyx. Superiorly they are connected wi
plexuses which enter the cranial cavity, while inferiorly they converge
the sacrum, and terminate in a loop on the coccyx. The sever
portions of the cords are distinguished as cervical, dorsal, lumbar, a
sacral, and in each of these parts the ganglia are equal in number,
nearly so, to the vertebræ against which they lie, except in the ne
where there are only three.

*Connection of the gangliated cords with the cerebro-spinal system.*—T
ganglia are severally connected with the anterior primary divisions
the spinal nerves in their neighbourhood by means of short filamen
each connecting filament consisting of a white and a grey portion, t
former of which may be considered as proceeding from the spinal ne
to the ganglion, the latter from the ganglion to the spinal nerve. At
upper end the gangliated cord communicates likewise with cer
cranial nerves. The main cords intervening between the ganglia, a
the smaller filaments connecting the ganglia with the spinal nerves, a
composed of a grey and a white part, the white being continuous w
the fibres of the spinal nerves prolonged to the ganglia.

From the connecting branches with the spinal nerves minute filaments (ner
sinu-vertebrales—Luschka) are given off, which pass inwards through the inte
vertebral foramina, where they are joined each by a filament from the trunk of t
corresponding spinal nerve, and are finally distributed to the dura mater and t

Fig. 364.—Diagrammatic outline of the sympathetic cord of one side in connection with the spinal nerves.

The full description of this figure will be found at p. 590.

On the right side the following letters indicate parts of the sympathetic nerves, viz.—*a*, superior cervical ganglion, communicating with the upper cervical spinal nerves and continued below into the great sympathetic cord; *b*, middle cervical ganglion; *c*, *d*, lower cervical ganglion united with the first dorsal; *d'*, eleventh dorsal ganglion; from the fifth to the ninth dorsal ganglia the origins of the great splanchnic nerve are shown; *l*, lowest dorsal or upper lumbar ganglion; *ss*, upper sacral ganglion. In the whole extent of the sympathetic cord, the twigs of union with the spinal nerves are shown.

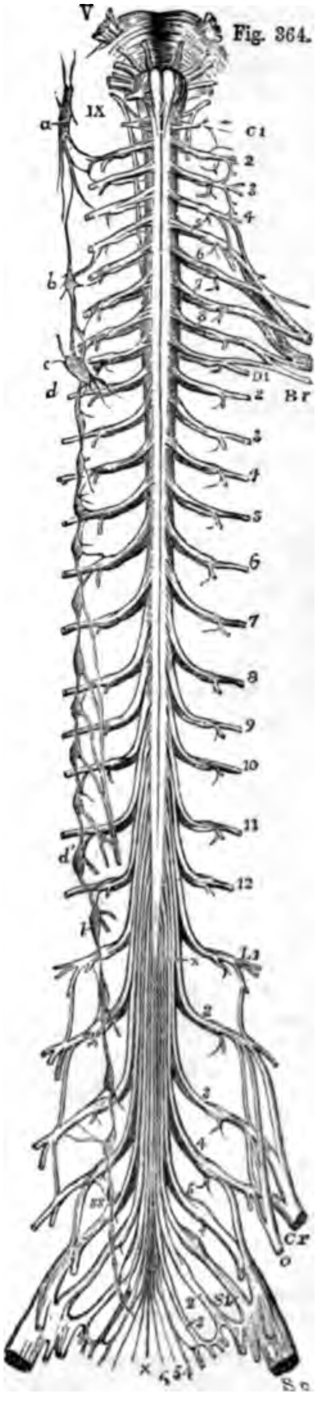


Fig. 364.

veins of the spinal canal, and to the bodies of the vertebræ (Luschka, "Die Nerven d. menschl. Wirbelkanales," Tübingen, 1850; Rüdinger, "Ueb. d. Verbreitung d. Sympathicus i. d. animalen Röhre;" München, 1863).

The **great prevertebral plexuses** comprise three large aggregations of nerves, or nerves and ganglia, situated in front of the spine, and occupying respectively the thorax, the abdomen, and the pelvis. They are single and median, and are named respectively the cardiac, the solar, and the hypogastric plexus. These plexuses receive branches from the cerebro-spinal nerves, as well as from both the gangliated cords above noticed, and they constitute centres from which the viscera are supplied with nerves.

## CERVICAL PART OF THE GANGLIATED CORD.

In the neck, each gangliated cord is deeply placed behind the sheath of the great cervical blood-vessels, and in contact with the muscles which immediately cover the fore part of the vertebral column. It comprises three ganglia, the first of which is placed near the base of the skull, the second in the lower part of the neck, and the third immediately above the neck of the first rib.

### UPPER CERVICAL GANGLION.

This is the largest ganglion of the great sympathetic cord. It is continued superiorly into an ascending branch, and tapers below into the connecting cord, so as to present usually a fusiform shape; but there is considerable variety in this respect in different cases, the ganglion being occasionally broader than usual, and sometimes constricted at intervals. It has the reddish-grey colour characteristic of the ganglia of the sympathetic system. It is placed on the rectus anticus major muscle, opposite the second and third cervical vertebræ, and behind the internal carotid artery.

**Connection with spinal nerves.**—At its outer side, the superior cervical ganglion is connected with the first four spinal nerves, by means of slender cords, which have the structure pointed out in the general description as being common to the series.

The circumstance of this ganglion being connected with so many as four spinal nerves, together with its occasionally constricted appearance, is favourable to the view that it may be regarded as consisting of several ganglia which have coalesced.

**Connection with cranial nerves.**—Small twigs connect the ganglion or its cranial cord with the lower ganglion of the pneumo-gastric, and with the twelfth cranial nerve, near the base of the skull; and another branch, which is directed upwards from the ganglion, divides at the base of the skull into two filaments, one of which ends in the petrous ganglion of the glosso-pharyngeal nerve; while the other, entering the jugular foramen, joins the ganglion of the root of the pneumo-gastric.

Besides the branches connecting it with cranial and spinal nerves, the first cervical ganglion gives off also the ascending branch, pharyngeal branches, the upper cardiac nerve, and branches to blood-vessels.

Fig. 365.

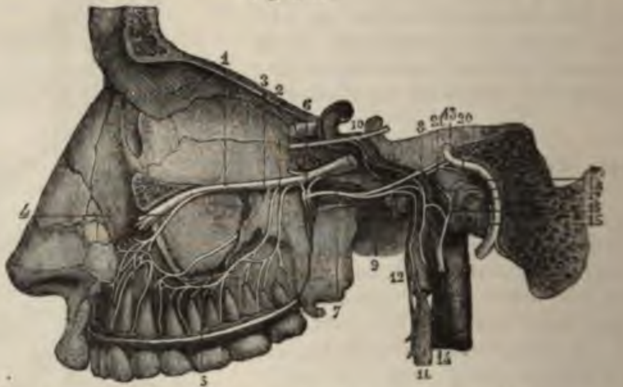


Fig. 365.—CONNECTIONS OF THE SYMPATHETIC NERVE THROUGH ITS CAROTID BRANCH WITH SOME OF THE CRANIAL NERVES.

The full description of this figure will be found at p. 561. The following numbers refer to sympathetic nerves and their connections: 6, spheno-palatine ganglion; 7, Vidian nerve; 9, large deep petrosal nerve; 10, a part of the sixth nerve, receiving twigs from the carotid plexus of the sympathetic; 11, superior cervical sympathetic ganglion; 12, its prolongation in the carotid branch; 15, tympanic nerve; 16, twig uniting it to the sympathetic.

1. ASCENDING BRANCH AND CRANIAL PLEXUSES.—The **ascending** or **carotid branch** of the first cervical ganglion is soft in texture and of a reddish tint, seeming to be in some degree a prolongation of the ganglion itself. In its course to the skull, it is concealed by the internal carotid artery, with which it enters the carotid canal in the temporal bone, and it is then divided into two parts, which are placed one on the outer, the other on the inner side of the vessel.

The *external division* distributes filaments to the internal carotid artery, receives one or two twigs from the tympanic branch of the glosso-pharyngeal (p. 578), and, after communicating by means of other filaments with the internal division of the cord, forms the *carotid plexus.*

The *internal division*, rather the smaller of the two, supplies filaments to the carotid artery, and goes to form the *cavernous plexus.* The terminal parts of these divisions of the cranial cord are prolonged on the trunk of the internal carotid, and extend to the cerebral and ophthalmic arteries, around which they form secondary plexuses, those on the cerebral arteries ascending to the pia mater. One minute plexus enters the eye-ball with the central artery of the retina.

It was stated by Ribes (Mem. de la Société Méd. d'Emulation, tom. viii., p. 606) that the cranial prolongations of the sympathetic nerves of the two sides coalesce with one another on the anterior communicating artery,—a small ganglion or a plexus being formed at the point of junction; but this connection has not been satisfactorily made out by other observers.

**Carotid plexus.**—The carotid plexus, situated on the outer side of the internal carotid artery at its second bend (reckoning from below), or between the second and third bends, joins the fifth and sixth cranial nerves, and gives many filaments to the vessel on which it lies.

*Branches.*—(*a*) The connection with the *sixth nerve* is established by means of one or two filaments of considerable size, which are supplied to that nerve where it lies by the side of the internal carotid artery.

(*b*) The filaments connected with the *Gasserian ganglion* of the fifth nerve proceed generally from the carotid plexus, but sometimes from the cavernous.

(*c*) The *large deep petrosal nerve* passes forwards from the outer side of the artery to the posterior aperture of the Vidian canal, where it joins the large superficial petrosal from the facial to form the Vidian nerve, which is continued to the spheno-palatine ganglion (p. 563).

(*d*) The *small deep petrosal nerve* passes from the carotid plexus backwards to the tympanic plexus (p. 578), and probably conveys sympathetic fibres to the latter.

**Cavernous plexus.**—The cavernous plexus, named from its position in the sinus of the same name, is placed below and rather to the inner side of the highest turn of the internal carotid artery. Besides giving branches on the artery, it communicates with the third, the fourth, and the ophthalmic division of the fifth cranial nerves.

*Branches.*—(*a*) The filament which joins the *third nerve* comes into connection with it close to the point of division of that nerve.

(*b*) The branch to the *fourth nerve*, which may be derived from either the cavernous or the carotid plexus, joins the nerve where it lies in the wall of the cavernous sinus.

(*c*) The filaments connected with the *ophthalmic trunk of the fifth nerve* are supplied to its inner surface.

(*d*) The *sympathetic root of the ophthalmic ganglion* passes from the cavernous plexus into the orbit, either separately, or in connection with the nasal nerve, or, according to Reichart, with the third nerve (p. 559).

(*e*) Minute filaments are furnished to the pituitary body.

2. PHARYNGEAL NERVES AND PLEXUS.—These nerves arise from the fore part of the ganglion, and are directed obliquely inwards to the side of the pharynx. Opposite the middle constrictor muscle they unite with branches of the pneumo-gastric and glosso-pharyngeal nerves; and by their union with these nerves the **pharyngeal plexus** is formed. Branches emanating from the plexus are distributed to the muscles and mucous membrane of the pharynx. One or two filaments pass from these branches to the superior and external laryngeal nerves.

3. UPPER CARDIAC NERVE.—Each of the cervical ganglia of the sympathetic furnishes a cardiac branch, the three being named respectively the upper, middle, and lower cardiac nerves.

These branches are continued singly, or in connection, to the large prevertebral centre (cardiac plexus) of the thorax. Their size varies considerably, and where one branch is smaller than common, another will be found to be increased in size, as if to compensate for the defect. There are some differences in the disposition of the nerves of the right and left sides.

The **upper** or **superficial cardiac nerve** of the *right side* proceeds from two or more branches of the ganglion, with, in some instances, an offset from the cord connecting the first two ganglia. In its course down the neck the nerve lies behind the carotid sheath, in contact with the longus colli muscle; and it is placed in front of the lower thyroid artery and the recurrent laryngeal nerve. Entering the thorax, it passes in some cases before, in others behind the subclavian artery, and is directed along the innominate artery to the back part of the arch of the aorta, where it ends in the deep cardiac plexus, a few small filaments continuing also to the front of the great vessel. Some branches accompany the inferior thyroid artery to be distributed to the thyroid body.

In its course downwards this cardiac nerve is repeatedly connected with other branches of the sympathetic, and with the pneumo-gastric nerve. Thus, about the middle of the neck it is joined by some filaments from the external laryngeal nerve; and, rather lower down, by one or two filaments from the trunk of the pneumo-gastric nerve (upper cervical cardiac branches): lastly, on entering the chest, it joins with the recurrent laryngeal.

**Variety.**—Instead of passing to the thorax in the manner described, the superior cardiac nerve may join the cardiac branch furnished from one of the other cervical ganglia. Scarpa describes this as the common disposition of the nerve: but Cruveilhier ("Anat. Descript.," t. iii., 707) states that he has not in any case found the cardiac nerves to correspond exactly with the figures of the "Tabulæ Neurologicæ."

The **upper cardiac nerve** of the *left side* has, while in the neck, the same course and connections as that of the right side. Within the chest it follows the left carotid artery to the arch of the aorta, and usually crosses over that vessel to enter the superficial cardiac plexus. In some cases, however, this nerve ends, either wholly or in part, in the deep cardiac plexus, and it then descends behind the arch of the aorta.

4. BRANCHES TO BLOOD-VESSELS.—The nerves which ramify on the arteries (**nervi molles**) spring from the front of the ganglion, and twine round the trunk of the external carotid artery. They are also prolonged on the branches of the artery, and form slender plexuses upon them. From the plexus on the facial artery is derived the filament which forms the sympathetic root of the submaxillary ganglion; and from that on

Fig. 366.

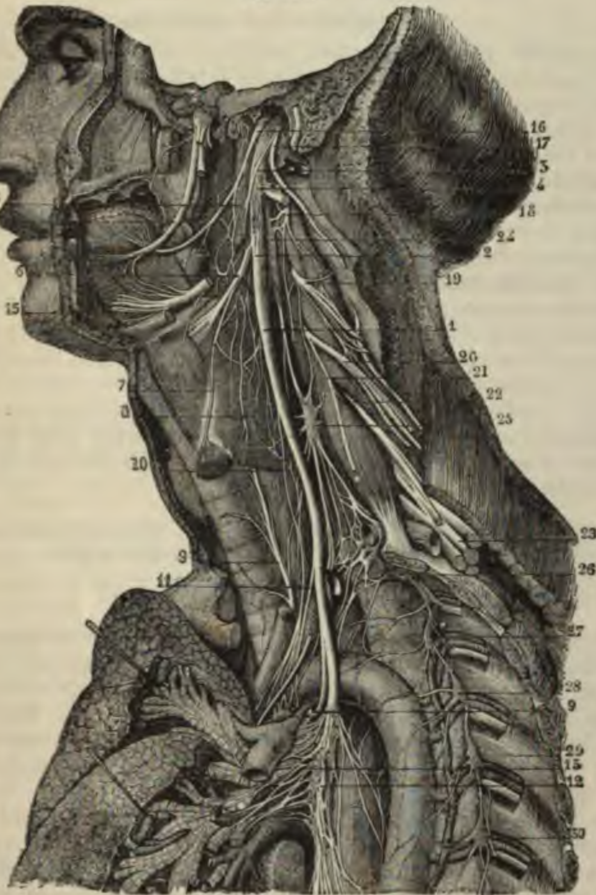


Fig. 366.—CONNECTIONS OF THE CERVICAL AND UPPER DORSAL SYMPATHETIC GANGLIA AND NERVES ON THE LEFT SIDE.

The full description of this figure will be found at p. 580. The following numbers refer to the sympathetic ganglia and nerves, and those immediately connected with them: 5, pharyngeal plexus; 12, 13, posterior pulmonary plexus; and to the reader's left, above the pulmonary artery, the superficial cardiac plexus; 24, superior cervical ganglion of the sympathetic; 25, middle cervical ganglion; 26, conjoined inferior cervical and first dorsal ganglia; 27, 28, 29, 30, second, third, fourth, and fifth dorsal ganglia.

the middle meningeal artery, twigs are described as extending to the otic ganglion, as well as to the geniculate ganglion of the facial nerve (external superficial petrosal nerve, p. 572). One filament descends from these nerves to the carotid gland.

Microscopic ganglia are frequently met with in the vascular plexuses, and several larger ones, of more constant occurrence, have been described. The most important of these is the *temporal ganglion*, of about a line in length, situated on the external carotid artery at the place of origin of the posterior auricular branch; it is said to receive a filament from the stylo-hyoid branch of the facial nerve.

### MIDDLE CERVICAL GANGLION.

The middle ganglion (thyroid ganglion), much the smallest of the cervical ganglia, is placed on or near the inferior thyroid artery, opposite the sixth cervical vertebra. It is usually connected with the fifth and sixth spinal nerves, but in a somewhat variable manner. It gives off thyroid branches and the middle cardiac nerve.

**Thyroid branches.**—From the inner side of the ganglion some twigs proceed along the inferior thyroid artery to the thyroid body, where they join the recurrent laryngeal and the external laryngeal nerves. While on the artery, these branches communicate with the upper cardiac nerve.

The **middle cardiac nerve** (deep or great cardiac nerve) of the *right side* is prolonged to the chest either in front of or behind the subclavian artery. In the chest it lies on the trachea, where it is joined by filaments of the recurrent laryngeal nerve, and it ends in the right side of the deep cardiac plexus. While in the neck, this nerve communicates with the upper cardiac nerve and the recurrent branch of the pneumo-gastric.

On the *left side*, the middle cardiac nerve enters the chest between the left carotid and subclavian arteries, and joins the left side of the deep cardiac plexus.

**Variety.**—The middle cervical ganglion is sometimes absent, and in that case the middle cardiac nerve is given off by the interganglionic cord.

### LOWER CERVICAL GANGLION.

The lower or third cervical ganglion is irregular in shape, usually somewhat flattened and round, or semilunar, and is frequently united to the first thoracic ganglion. Placed in a hollow between the transverse process of the last cervical vertebra and the neck of the first rib, it is concealed by the vertebral artery. It is connected by short communicating cords with the lowest two cervical nerves. Its branches are the lower cardiac nerve, and offsets to blood-vessels.

The **lower cardiac nerve**, issuing from the third cervical ganglion or from the first thoracic, inclines inwards on the *right side*, behind the subclavian artery, and terminates in the cardiac plexus behind the arch of the aorta. It communicates with the middle cardiac and recurrent laryngeal nerves behind the subclavian artery.

On the *left side*, the lower cardiac often becomes blended with the middle cardiac nerve, and the cord resulting from their union terminates in the deep cardiac plexus.

**Branches to blood vessels.**—From the lowest cervical and first dorsal ganglia slender branches ascend along the vertebral artery in its canal, forming a plexus round the vessel by their intercommunications and supplying it with offsets. This plexus is connected with the cervical spinal nerves as they cross the vertebral artery, and its ultimate ramifications are continued on the intracranial branches of the vertebral and basilar arteries.

One or two branches pass from the middle cervical ganglion to the lower cervical or first dorsal ganglion in front of the subclavian artery, forming loops round the vessel (ansæ Vieussenii), and supplying it with small offsets.

## THORACIC PART OF THE GANGLIATED CORD.

In the thorax, the gangliated cord is placed at the side of the spinal column, along a line passing over the heads of the ribs. It is covered by the pleura, and crosses the intercostal blood-vessels.

Opposite the head of each rib the cord usually presents a ganglion, so that there are commonly twelve of these ; but, from the occasional coalescence of two, the number varies slightly. The first ganglion when distinct is larger than the rest, and is of an elongated form ; but it is often blended with the lower cervical ganglion. The rest are small, generally oval, but very various in form.

**Connection with spinal nerves.**—The branches of connection between the dorsal nerves and the ganglia of the sympathetic are usually two in number for each ganglion ; one of these generally resembling the spinal nerve in structure, the other more similar to the sympathetic nerve.

### BRANCHES OF THE GANGLIA.

The branches furnished by the *first five or six ganglia* are small, and are distributed in a great measure to the thoracic aorta, the vertebræ, and ligaments. Several of these branches enter the posterior pulmonary plexus (p. 585).

The branches furnished by the *lower six or seven ganglia* unite into three cords on each side, which pass down to join plexuses in the abdomen, and are distinguished as the great, the small, and the smallest splanchnic nerves.

**Great splanchnic nerve.**—This nerve is formed by the union of small cords (roots) given off by the thoracic ganglia from the fifth or sixth to the ninth or tenth inclusive. By careful examination of specimens after immersion in acetic or diluted nitric acid, small filaments may be traced from the splanchnic roots upwards as far as the third ganglion, or even as far as the first (Beck, Phil. Trans., 1846).

Gradually augmented by the successive addition of the several roots, the cord descends obliquely inwards over the bodies of the dorsal vertebræ ; and, after perforating the crus of the diaphragm, terminates in the semilunar ganglion, frequently sending some filaments to the renal plexus and the suprarenal body.

The splanchnic nerve is remarkable from its white colour and firmness, which are owing to the preponderance of spinal nerve-fibres in its composition.

**Varieties.**—In the chest the great splanchnic nerve is not unfrequently divided into parts, and forms a plexus with the small splanchnic nerve. Occasionally also a small ganglion (splanchnic ganglion) is formed on it over the last dorsal vertebra, or the last but one ; and when it presents a plexiform

Fig. 367.

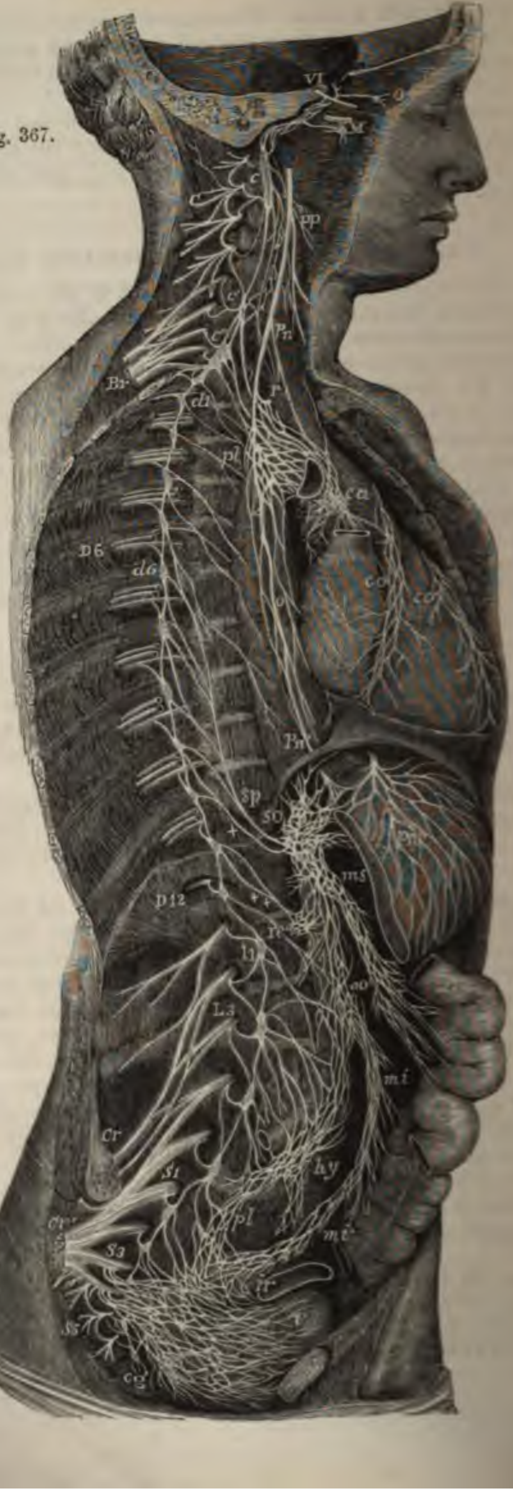

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Fig. 367.—DIAGRAMMATIC VIEW OF THE SYMPATHETIC CORD OF THE RIGHT SIDE, SHOWING ITS CONNECTIONS WITH THE PRINCIPAL CEREBRO-SPINAL NERVES AND THE MAIN PREAORTIC PLEXUSES. ¼

*Cerebro-spinal Nerves.*—VI, a portion of the sixth cranial nerve as it passes through the cavernous sinus, receiving two twigs from the carotid plexus of the sympathetic nerve; O, ophthalmic ganglion, connected by a twig with the cavernous plexus; M, connection of the spheno-palatine ganglion by the large deep petrosal nerve with the carotid plexus; C, cervical plexus; Br, brachial plexus; D 6, sixth dorsal nerve; D 12, twelfth; L 3, third lumbar nerve; S 1, first sacral nerve; S 3, third; S 5, fifth; Cr, anterior crural nerve; Cr′, great sciatic; *pn*, pneumo-gastric nerve in the lower part of the neck; *r*, recurrent nerve, winding round the subclavian artery.

*Sympathetic Cord.*—*c*, superior cervical ganglion; *c′*, middle; *c″*, inferior; from each of these ganglia cardiac nerves (all deep on this side) are seen descending to the cardiac plexus; *d* 1, placed immediately below the first dorsal sympathetic ganglion; *d* 6, is opposite the sixth; *l* 1, first lumbar ganglion; *c g*, the terminal or coccygeal ganglion.

*Preaortic and Visceral Plexuses.*—*pp*, pharyngeal plexus; *pl*, posterior pulmonary plexus, spreading from the pneumo-gastric on the back of the right bronchus; *ca*, on the aorta, the cardiac plexus, towards which, in addition to the cardiac nerves from the three cervical sympathetic ganglia, other branches are seen descending from the pneumo-gastric and recurrent nerves; *co*, right or posterior, and *co′*, left or anterior coronary plexus; *o*, œsophageal plexus in long meshes on the gullet; *sp*, great splanchnic nerve; +, small splanchnic; + +, smallest splanchnic; the first and second of these are shown joining *so*, the solar plexus; the third descending to *re*, the renal plexus; connecting branches between the solar plexus and the pneumo-gastric nerves are also represented; *pn′*, above the place where the right pneumo-gastric passes to the posterior surface of the stomach; *pn″*, the left, distributed on the anterior surface of the cardiac portion of the organ; from the solar plexus large branches are seen surrounding the arteries of the cœliac axis, and descending to *ms*, the superior mesenteric plexus; opposite to this is an indication of the suprarenal plexus; below *re* (the renal plexus), the spermatic plexus is also indicated; *ao*, on the front of the aorta, marks the aortic plexus, formed by nerves descending from the solar and superior mesenteric plexuses and from the lumbar ganglia; *mi*, the inferior mesenteric plexus, surrounding the corresponding artery; *hy*, hypogastric plexus, placed between the common iliac arteries, connected above with the aortic plexus, receiving nerves from the lower lumbar ganglia, and dividing below into the right and left pelvic or inferior hypogastric plexuses; *pl*, right pelvic plexus; from this the nerves descending are joined by those from the plexus on the superior hæmorrhoidal vessels *mi′*, by sympathetic nerves from the sacral ganglia, and by numerous visceral nerves from the third and fourth sacral spinal nerves, and there are thus formed the rectal, vesical, and other plexuses, which ramify upon the viscera from behind forwards, and from below upwards, as towards *ir*, and *v*, the rectum and bladder.

arrangement, several small ganglia have been observed on its divisions. According to Cunningham, the splanchnic ganglion is always present on the right side (Journ. Anat., ix., 303).

In eight instances out of a large number of bodies, Wrisberg observed a fourth splanchnic nerve (nervus splanchnicus supremus). It is described as formed by offsets from the cardiac nerves, and from the lower cervical as well as some of the upper thoracic ganglia. ("Observ. Anatom. de Nerv. Viscerum particula prima," p. 25, sect. 3.)

**Small splanchnic nerve.**—The small or second splanchnic nerve springs from the tenth and eleventh ganglia, or from the neighbouring part of the cord. It passes along with the preceding nerve, or separately, through the diaphragm, and ends in the cœliac plexus. In the chest, this nerve often communicates with the large splanchnic nerve; and in some instances it furnishes filaments to the renal plexus, especially if the lowest splanchnic nerve is very small or wanting.

**Smallest splanchnic nerve.**—This nerve (nerv. renalis posterior—Walter) arises from the twelfth thoracic ganglion, and communicates sometimes with the nerve last described. After piercing the diaphragm, it ends in the renal plexus, and in the inferior part of the cœliac plexus.

## LUMBAR PART OF THE GANGLIATED CORD.

In the lumbar region, the two gangliated cords approach one ano more nearly than in the thorax. They are placed before the bodi the vertebræ, each lying along the inner margin of the psoas mu and that of the right side is partly covered by the vena cava, that o left by the aorta.

The ganglia are small, and of an oval shape. They are comm four in number, but occasionally their number is diminished, and are then of larger size.

**Connection with spinal nerves.**—In consequence of the greate tance at which the lumbar ganglia are placed from the intervertebral mina, the branches of connection with the spinal nerves are longer th other parts of the gangliated cord. There are generally two conne branches for each ganglion, but the number is not so uniform as it the chest; nor are those belonging to any one ganglion connected al with the same spinal nerve. The connecting branches accompan lumbar arteries, and, as they cross the bodies of the vertebræ, are co by the fibrous bands which give origin to the psoas muscle.

BRANCHES.—The branches of these ganglia are uncertain in number. Some join the plexus on the aorta; others descending g form the hypogastric plexus. Several filaments are distributed to vertebræ and the ligaments connecting them.

## SACRAL PART OF THE GANGLIATED CORD.

Over the sacrum, the gangliated cord of the sympathetic nerve is r diminished in size, and gives but few branches to the viscera. position on the front of the sacrum is along the inner side of the ant sacral foramina; and like the two series of those foramina, the righ left cords approach one another in their progress downwards. The u end of each is united to the last lumbar ganglion by a single or a d interganglionic cord; and at the lower end they are connected by m of a loop, in which a single median ganglion, *ganglion impar* or *coc ganglion*, placed on the fore part of the coccyx, is often found. sacral ganglia are usually four in number; but the variation bo size and number is more marked in these than in the thoracic or lu ganglia.

**Connection with spinal nerves.**—From the proximity of the s ganglia to the spinal nerves at their emergence from the foramin communicating branches are very short: there are usually two for ganglion, and these are in some cases connected with different nerves. The coccygeal nerve communicates with the last sacral, c coccygeal ganglion.

BRANCHES.—The branches proceeding from the sacral gangli much smaller than those from other ganglia of the cord. The for the most part expended on the front of the sacrum, and joi corresponding branches from the opposite side. Some filaments one or two of the upper ganglia enter the pelvic plexus, while o go to form a plexus on the middle sacral artery. From the loop necting the two cords, filaments are given to the coccyx and to the ments about it, and to the coccygeal gland.

[illegible] artery, are d[illegible]

[illegible] a few filaments are co[illegible]

[illegible] pass forwards by th[illegible] [illegible] cardiac plexu[illegible], but th[illegible]

[illegible] sends filaments to th[illegible]

—The *right coronary plexus* [illegible] cardiac plexuses, the filaments [illegible] embracing the root of the aorta. It accompanies the right coro artery on the heart, sending its branches upwards and downwards to auricle and ventricle.

The *left coronary plexus* is larger than the right, and is derived m from the left half of the deep cardiac plexus. Being directed forw between the pulmonary artery and the left auricular appendage, it re the left coronary artery, and subdivides into two principal portions w accompany the primary divisions of that vessel.

Nervous filaments ramify in great number under the pericardium, espe on the ventricular portion of the heart. They are not so easily distinguist man as in some animals. In the heart of the calf or the lamb they are dist seen without dissection, running in lines which cross obliquely the mu fibres. Remak was the first to observe that these branches are furnished small ganglia, both on the surface and in the muscular substance (M "Archiv," 1844). For a description of the Ganglia and Nerves of the from original observations, see I. Bell Pettigrew, "Physiol. of the Circula &c., 1874, p. 293.

### SOLAR OR EPIGASTRIC PLEXUS.

The solar or epigastric plexus, the largest of the prever centres, is placed at the upper part of the abdomen, behind the sto and in front of the aorta and the pillars of the diaphragm. Surrou the origin of the cœliac axis and the superior mesenteric artery, it pies the interval between the suprarenal bodies, and extends down as far as the pancreas. The plexus consists of nervous cords, several ganglia of various sizes connected with them. The splanchnic nerve on both sides, and some branches of the pn gastric, terminate in it. The branches given off from it are numerous, and accompany the arteries to the principal viscera abdomen, constituting so many secondary plexuses on the v Thus, diaphragmatic, cœliac, mesenteric, and other plexuses are nised, which follow the corresponding arteries.

**Semilunar ganglia.**—The solar plexus contains, as already tioned, several ganglia: and by the size of these bodies it is disting from the other prevertebral plexuses. The two principal gan masses, named *semilunar*, though they have often little of the for name implies, occupy the upper and outer part of the plexus, one o side, and are placed close to the suprarenal bodies by the side cœliac and the superior mesenteric arteries. At the upper end, w expanded, each ganglion receives the great splanchnic nerve.

**Diaphragmatic** or **phrenic plexus.**—The nerves composin plexus are derived from the upper part of the semilunar ganglio are larger on the right than on the left side. Accompanying the a along the lower surface of the diaphragm, the nerves sink into th stance of the muscle. They furnish some filaments to the sup body, and join with the spinal phrenic nerves.

At the right side, on the under surface of the diaphragm, and n suprarenal body, there is a small ganglion, (*diaphragmatic* or *ganglion*,) which marks the junction between the phrenic nerves spinal and sympathetic systems. From this small ganglion fila are distributed to the vena cava, the suprarenal body, and the h plexus. On the left side the ganglion is wanting.

**Suprarenal plexus.**—The suprarenal nerves issue from the plexus and the outer part of the semilunar ganglion, a few filaments being added from the diaphragmatic plexus. They are short, but numerous in comparison with the size of the body which they supply: they enter the upper and inner parts of the suprarenal capsule. These nerves are continuous below with the renal plexus. The plexus is joined by branches from one of the splanchnic nerves, and presents a ganglion (*gangl. splanchnico-suprarenale*), where it is connected with those branches. The plexus and ganglion are smaller on the left than on the right side.

**Renal plexus.**—The nerves forming the renal plexus, fifteen or twenty in number, emanate for the most part from the outer side of the semilunar ganglion; but some are added from the solar and aortic plexuses. Moreover, filaments from the smallest splanchnic nerve, and occasionally from the other splanchnic nerves, terminate in the renal plexus. In their course along the renal artery, ganglia of different sizes (*renal ganglia*) are formed on these nerves. Lastly, dividing with the branching of the vessel, the nerves follow the renal arteries into the substance of the kidney. On the right side some filaments are furnished to the vena cava, behind which the plexus passes with the renal artery; and on both sides offsets pass to the spermatic plexus.

**Spermatic plexus.**—This small plexus commences in the renal, but receives in its course along the spermatic artery an accession from the aortic plexus. Continuing downwards to the testis, the spermatic nerves are connected with others which accompany the vas deferens and its artery from the pelvis.

In the female, the plexus, like the artery, is distributed to the ovary and the uterus.

**Cœliac plexus.**—This plexus is of large size, and is derived from the fore part of the great epigastric plexus. It surrounds the cœliac axis in a kind of membranous sheath, and subdivides, with the artery, into coronary, hepatic, and splenic plexuses, the branches of which form communications corresponding with the arches of the arterial anastomosis. The plexus receives offsets from one or more of the splanchnic nerves, and on the left side a considerable branch from the right pneumo-gastric nerve is continued into it.

The *coronary plexus* is placed with its artery along the small curvature of the stomach, and unites with the nerves which accompany the pyloric artery, as well as with branches of the pneumo-gastric nerves. The nerves of this plexus enter the coats of the stomach, after running a short distance beneath the peritoneum.

The *hepatic plexus*, the largest of the three divisions of the cœliac plexus, ascends with the hepatic vessels and the bile-duct, and, entering the substance of the liver, ramifies on the branches of the portal vein and the hepatic artery. Offsets from the left pneumo-gastric nerve join the hepatic plexus at the left side of the vessels. From this plexus filaments are furnished to the right suprarenal plexus, as well as other secondary plexuses which follow the branches of the hepatic artery. Thus there is a *cystic plexus* to the gall-bladder; and there are *pyloric*, *gastro-epiploic*, and *pancreatico-duodenal plexuses*, which unite with coronary, splenic, and mesenteric nerves.

The *splenic plexus*, continued on the splenic artery and its branches into the substance of the spleen, is reinforced at its beginning by branches from the left semilunar ganglion, and by filaments from the right vagus nerve. It furnishes the *left gastro-epiploic* and *pancreatic plexuses*, which course along the corresponding branches of the splenic artery, and, like the vessels, are distributed to the stomach and pancreas.

**Superior mesenteric plexus.**—The plexus accompanying the superior mesenteric artery, whiter in colour and firmer than any of the preceding offsets of the solar plexus, envelopes the artery in a membraniform sheath, and receives a prolongation from the junction of the right pneumo-gastric nerve with the cœliac plexus. Near the root of the artery, ganglionic masses (gangl. meseraica) occur in connection with the nerves of this plexus.

The offsets of the plexus are in name and distribution the same as the vessels. In their progress to the intestine some of the nerves quit the arteries which first supported them, and are directed forwards in the intervals between the vessels. As they proceed they divide, and unite with lateral branches, like the arteries, but without the same regularity: they finally pass upon the intestine along the line of attachment of the mesentery.

**Aortic plexus.**—The aortic or intermesenteric plexus, placed along the abdominal aorta, and occupying the interval between the origins of the superior and inferior mesenteric arteries, consists, for the most part, of two lateral cords, connected with the semilunar ganglia and renal plexuses, which are extended on the sides of the aorta, and which meet in several communicating branches over the front of that vessel. It is joined by branches from some of the lumbar ganglia, and presents not unfrequently one or more distinct ganglionic enlargements towards its centre.

The aortic plexus furnishes the inferior mesenteric plexus and part of the spermatic, gives some filaments to the lower vena cava, and ends below in the hypogastric plexus.

**Inferior mesenteric plexus.**—This plexus is derived principally from the left lateral part of the aortic plexus, and closely surrounds with a network the inferior mesenteric artery. It distributes nerves to the left or descending part and the sigmoid flexure of the colon, and assists in supplying the rectum. The nerves of this plexus, like those of the superior mesenteric plexus, are firm in texture and of a whitish colour.

The highest branches (those on the left colic artery) are connected with the last branches (middle colic) of the superior mesenteric plexus, while others in the pelvis unite with offsets derived from the pelvic plexus.

### HYPOGASTRIC PLEXUS.

The hypogastric plexus, the assemblage of nerves destined for the supply of the viscera of the pelvis, lies, invested in a sheath of dense connective tissue, in the interval between the two common iliac arteries. It is formed by the prolongations of the aortic plexus on each side, which receive considerable branches from the lumbar ganglia, and, after crossing the common iliac artery, interlace in the form of a flat plexiform mass placed in front of the lowest lumbar vertebra. The plexus contains no distinct ganglia. At the lower end it divides into two parts, which are directed forwards, one to each side of the pelvic viscera, and form the pelvic plexuses.

### PELVIC PLEXUS.

The pelvic or inferior hypogastric plexuses, one on each side, are placed in the lower part of the pelvic cavity by the side of the rectum, and of the vagina in the female. The nerves, continued from the hypogastric plexus, enter into repeated communications as they descend, and form at the points of connection small knots, which contain a little ganglionic matter. After descending some way, they become united with branches of the spinal nerves, as well as with a few offsets of the sacral ganglia, and the union of all constitutes the pelvic plexus. The spinal branches which enter into the plexus are furnished from the third and fourth sacral nerves, occasionally also the second. Small ganglia are formed at the places of union of the spinal nerves, as well as elsewhere in the plexus (plexus gangliosus—Tiedemann).

From the plexus so constituted, numerous nerves are distributed to the pelvic viscera. They correspond with the branches of the internal iliac artery, and vary with the sex; thus, besides hæmorrhoidal and vesical nerves, which are common to both sexes, there are nerves special to each:—namely, in the male for the prostate, vesicula seminalis, and vas deferens; in the female, for the vagina, uterus, ovary, and Fallopian tube.

The nerves distributed to the urinary bladder and the vagina contain a larger proportion of spinal nerves than those furnished to the other pelvic viscera.

**Hæmorrhoidal plexus.**—These slender nerves proceed from the back part of the pelvic plexus. They join with the nerves (superior hæmorrhoidal) which descend with the inferior mesenteric artery, and penetrate the coats of the rectum.

**Vesical plexus.**—The nerves of the urinary bladder are very numerous. They are directed from the anterior part of the pelvic plexus to the side and lower part of the bladder. At first these nerves accompany the vesical blood-vessels, but afterwards they leave the vessels, and subdivide into minute branches before perforating the muscular coat of the organ. Secondary plexuses are given in the male to the vas deferens and the vesicula seminalis.

The *nerves of the vas deferens* ramify round that tube, and communicate in the spermatic cord with the nerves of the spermatic plexus. Those furnished to the *vesicula seminalis* form an interlacement on the vesicula, and some branches penetrate its substance. Other filaments from the prostatic nerves reach the same structure.

**Prostatic plexus.**—The nerves of this plexus are of considerable size, and pass onwards between the prostate gland and the levator ani. Some are furnished to the prostate and to the vesicula seminalis; and the plexus is then continued forwards to supply the erectile substance of the penis, where its nerves are named *cavernous*.

*Cavernous nerves* of the penis.—These are very slender, and difficult to dissect. Continuing from the prostatic plexus, they pass onwards beneath the arch of the pubis, and through the muscular structure connected with the membranous part of the urethra, to the dorsum of the penis. At the root of the latter, the cavernous nerves are joined by some short filaments from the pudic nerve. Having distributed twigs to the fore part of the prostate and the membranous part of the urethra, these nerves divide into branches for the erectile substance of the penis, as follows:—

The *small cavernous nerves* (Müller) perforate the fibrous coveri of the corpus cavernosum near the root of the penis, and end in t erectile substance.

The *large cavernous nerve*, which extends forwards on the dorsum the penis, and dividing, gives filaments that penetrate the corp cavernosum, and pass with or near the cavernous artery. As it co tinues onwards, this nerve joins with the dorsal branch of the pu nerve about the middle of the penis, and is distributed to the corp cavernosum. Branches from the foregoing nerves reach the corp spongiosum urethræ. (Müller, "Ueber die organischen Nerven d erectilen männlichen Geschlechtsorgane," &c. Berlin, 1836.)

**Vaginal plexus.**—The nerves furnished to the vagina leave t lower part of the pelvic plexus—that part with which the spinal ner are more particularly combined. They are distributed to the vag without previously entering into a plexiform arrangement; and th end in the erectile tissue on the lower and anterior part, and in t mucous membrane.

**Nerves of the uterus.**—These nerves are derived mainly fr the lateral fasciculus prolonged to the pelvic plexus from the hyp gastric plexus, but some filaments are also added from the third a fourth sacral nerves. They are directed upwards with the blood-vess between the layers of the broad ligament, along the side of the ut and some slender filaments accompany the branches of the uterine art but the larger number of the nerves sink directly into the substance the uterus, penetrating for the most part its neck and the lower port of its body. They form connections in the broad ligament with t ovarian nerves, and the fundus of the uterus also receives an offset fr that plexus. Numerous ganglia are contained in the plexus by the s of the cervical portion of the uterus, but they have not been found in muscular substance. One branch, continued directly from the comm hypogastric plexus, reaches the hinder surface of the body of the ute above the rest; and a nerve from the same source ascends to the Fa pian tube. (Fr. Tiedemann, "Tab. Nerv. Uteri," Heidelberg, 18 Robert Lee, in Phil. Trans. 1841, 1842, 1846, and 1849; Snow Be in Phil. Trans., 1846, part ii.; and F. Frankenhäuser, "Die Nerv der Gebärmutter," 1867.)

The *nerves of the gravid uterus* have been frequently investiga with a view to discover if they become enlarged along with the incre in size of the organ. It is ascertained that the increase which ta place is confined, for the most part to the thickening of the fibr envelopes of the nerves; but it appears also, from the researches Kilian, that fibres furnished with a medullary sheath, which in the u impregnated state of the uterus lose that sheath as they proceed to th distribution, in the impregnated condition of the uterus continu be surrounded with it as they run between the muscular fibres. (Fr in Supplement of Cyclopædia of Anat. and Phys., "Uterus and A pendages.")

# SUPERFICIAL AND TOPOGRAPHICAL ANATOMY.

IN this section will be comprised, 1, a brief account of the external
nformation of the body, including the relation of its anatomical con-
ituents to its surface forms, and the mode of determining the position
deep seated organs, such as the viscera, large vessels, and other im-
rtant parts ; and 2, the topographical and surgical anatomy of the
guinal and perineal regions.

## SUPERFICIAL ANATOMY OF THE HEAD AND NECK.

### THE HEAD AND FACE.

The upper part of the cranium is but thinly covered by the scalp, and
e form of the head is almost exactly that of the skull. The bones
n be readily examined by passing the hand over the head, and the
llowing parts are thus to be distinguished :—In the middle line behind
the external occipital protuberance, from which the superior curved
e proceeds outwards on each side towards the mastoid process ; below
is line the bone is obscured by the overlying muscles. Above the
cipital protuberance, the lambdoid suture is often to be followed as a
ght depression on the surface. At the fore part of the lateral region
the head the temporal crest of the frontal bone becomes prominent,
d leads down to the external angular process, the junction of which
th the malar bone is marked by a distinct depression. Below this the
tline of the malar bone can be followed, and from the hinder part of
e latter the finger passes along the zygoma to its base in front of the
r. Higher up on the side of the head the temporal line on the parietal
ne is frequently to be recognised, indicating the extent upwards of the
nporal muscle. The margin of the orbit can be felt in its whole
tent, and is found to be interrupted above, about the junction of the
ner and middle thirds, by the supraorbital notch, unless this be con-
rted into a foramen, when it is scarcely perceptible. Above the orbit
the superciliary ridge, small in the female and absent in the child, and
ten rendered more prominent by a largely developed frontal sinus ;
ove this on the forehead is the frontal eminence, which is, on the
her hand, most marked during childhood. In the infant, the anterior
ntanelle is felt as a lozenge-shaped depression, leading forwards to the
terval between the two frontal, and backwards to that between the two
rietal bones ; the latter interval conducts to the triradiate posterior
ntanelle, the lateral limbs of which are continued downwards along the
pper margins of the occipital bone.

The supraorbital nerve and artery pass almost vertically upwards from
the supraorbital notch, and more internally the frontal artery and supra-
trochlear nerve ascend over the margin of the orbit, while the large frontal
vein descends in a similar position to the root of the nose. Posteriorly,
the occipital vessels and great occipital nerve run upwards to the vertex,
entering the scalp somewhat internal to a point midway between the
external occipital protuberance and the mastoid process. The super-
ficial temporal artery crosses the base of the zygoma immediately in
front of the ear, and its anterior branch can frequently be seen, especially
in old persons, running upwards and forwards with a tortuous course
over the fore part of the temporal muscle towards the forehead.

In contact with the inner surface of the cranial wall, the superior
longitudinal sinus is directed backwards along the middle line, extending
from the lower part of the forehead to the external occipital protuber-
ance; from the latter point the lateral sinus runs horizontally outwards
and forwards to a spot about an inch behind the external auditory
meatus, where it turns downwards towards the mastoid process. The
anterior and larger branch of the middle meningeal artery runs upward
and backwards within the skull in the fore part of the temporal region
a point two inches above the zygoma and two inches behind the level
the external angular process marks the spot where the vessel is leavi
the deep groove or canal which it occupies on the anterior inferior an
of the parietal bone.

The extent downwards of the cerebrum is indicated by a line draw
the direction of the eyebrow about one-sixth of an inch above the u
margin of the orbit, and then carried backwards and downwards on
side of the head over the posterior root of the zygoma to the ext
occipital protuberance. The bifurcation of the fissure of Sylvius c
sponds to a point one inch and a quarter behind, and a quarter of an
above the level of, the external angular process: from this poin
anterior limb of the fissure ascends almost vertically for nearly an
while the posterior limb runs backwards and a little upwards
distance of about three inches, and terminates beneath the p
eminence. The upper end of the furrow of Rolando is placed abou
an inch behind a point midway between the root of the nose an
external occipital protuberance; its lower end is close to the p
limb, and about an inch behind the bifurcation, of the fissure of Sy
The external parieto-occipital fissure is directed transversely out
for somewhat less than an inch, from the apex of the lambdoid s
the latter spot being situated between two and three inches abo
external occipital protuberance.

In the face proper, the nasal bones and the margin of the a
nasal aperture are readily traced, and at the lower part of the lat
the root of the columna nasi, the anterior nasal spine is felt. In
of this opening the form of the upper and lower lateral cartilages
distinguished, and the inner portion of the latter is more clearly
out by passing the finger into the nostril, by which means part
cartilage of the septum, the lower margin of the upper lateral car
and sometimes the tip of the inferior turbinate bone can also be fe

Below the base of the zygoma, the temporo-maxillary articula
quite superficial behind the upper part of the masseter, and fro
condyle the posterior margin of the ramus of the lower jaw can b
lowed to the angle. The lower margin of the jaw can also b

throughout, and ascending from its central point the anterior edge of the masseter. Immediately in front of the latter, the facial artery crosses the base of the jaw, and is readily found by its pulsation; the course of the vessel is roughly marked by a line passing upwards a little outside the corner of the mouth and continued by the side of the nose to the inner canthus of the eye. The coronary branch of the artery may be felt pulsating beneath the mucous membrane in each lip very near its free border. Stenson's duct runs generally in the direction of a line drawn from the lower margin of the concha of the ear to a point midway between the ala of the nose and the free margin of the lip, but it varies somewhat in position in different subjects; accompanying the duct are the transverse facial vessels and the infraorbital branches of the facial nerve. The interval between the ramus of the jaw and the mastoid process is occupied by the parotid gland, a part of which extends forwards over the masseter muscle, and the trunk of the facial nerve is deeply placed beneath the gland; the position of the nerve may be indicated by a line running downwards and forwards from the anterior border of the mastoid process at the point where it meets the ear. A line carried downwards over the face, crossing the supraorbital notch and the interval between the two bicuspid teeth of the lower jaw, will be found to be nearly vertical and to pass over the infraorbital and mental foramina, thus forming a guide to the spots at which the largest cutaneous branches of the three trunks of the fifth nerve come to the surface.

About the anterior half of the eyeball can be felt in the aperture of the orbit; it gives a tense elastic sensation to the fingers. At the upper and inner angle of the orbital opening the pulley of the superior oblique muscle may also be felt.

The skin of the eyelid is very soft and thin; at the free margin of each lid it passes into the conjunctiva along the line of the eyelashes, and within this a sharp edge is formed, especially in the case of the lower lid, which is closely applied to the surface of the eyeball. The palpebral fissure is somewhat oval, or widely fusiform, in shape, but the margin of the upper lid is more arched than that of the lower. The fissure is also generally a little inclined from without inwards and downwards.

The whole length of the palpebral fissure is about an inch and a quarter; its breadth is scarcely sufficient, unless when the eyes are unusually widely opened, to expose the whole of the cornea; but these dimensions, especially the latter, vary considerably in different persons, thus causing the eye to appear larger or smaller, although the size of the globe itself is relatively very constant. At the outer canthus, the lids meet in an acute angle; at the inner, the fissure is prolonged downwards and inwards for about a quarter of an inch between portions of the lid-margins, which are straight and rounded. The junction of the curved and straight portions of the margin is marked by a slight elevation, the *papilla lachrymalis*, which is much better developed in the lower lid than the upper, and on drawing the lid forwards a minute opening, the *punctum lachrymale*, is seen on the summit of the papilla, leading into the canaliculus by which the tears are conveyed into the lachrymal sac. In the neighbourhood of the inner canthus the lids are separated from the eyeball by the *caruncula lachrymalis*, a red fleshy-looking portion of skin, which supports a few fine hairs, and by the fold of mucous membrane known as the *plica semilunaris*.

The lids can be readily everted, the lower one by simply pulling it downwards, the upper one by turning it over a probe, and the ocular and palpebral conjunctiva can thus be completely examined; the former is transparent and smooth, presenting only a few minute vessels in the healthy state; the latter is more or less red and velvetty in appearance. The Meibomian glands are seen at the same time, appearing through the conjunctiva as lines of yellowish granules arranged perpendicularly to the edges of the lids, and along the latter the openings of their ducts are visible in the form of minute spots within the line of the eyelashes.

If the eyelids are drawn forcibly outwards, the internal tarsal ligament, or tendo oculi, is made to project between the inner canthus and the margin of the orbit, and this band can also be felt as it is tightened during the act of winking. Behind the tarsal ligament, and reaching to a somewhat higher level, is the lachrymal sac, and into the latter the canaliculi open, taking a course from the puncta lachrymalia, at first vertically, and then nearly horizontally, the one above and the other below the ligament. A knife entered immediately below the internal tarsal ligament will open the lower part of the lachrymal sac, and a probe may then be passed through the incision, in a direction downwards and slightly backwards and outwards, along the nasal duct into the nose.

On looking into the mouth, the teeth are seen, and by everting the lips, the outer surface of the gums may be inspected, and the alveolar processes can be examined with the finger. The smooth mucous membrane lining the lips is thus exposed, and in the middle line, passing from each lip to the jaw, is a thin fold termed the frænum; of these the upper one is the larger. On pulling the angle of the mouth outwards, the lining membrane of the inside of the cheek can be examined, and the papilla on which the duct of Stenson opens may be seen and felt opposite the second molar tooth of the upper jaw: with some difficulty a fine probe may be made to enter the aperture. A little farther back, if the mouth be alternately opened and shut, it is easy to distinguish the anterior border of the masseter and temporal muscles as well as the edge and inner surface of the ramus of the jaw.

By raising the tongue, the inner aspect of the gums and the floor of the mouth are brought into view. The under surface of the tongue is smooth, and is connected in the middle line with the floor of the mouth by the frænum linguæ, a fold of mucous membrane similar to, but much larger than, the fræna of the lips; from this a fine line is continued forwards to the tip of the tongue. Somewhat less than half an inch external to the frænum, on each side, the ranine vein is clearly seen through the delicate mucous membrane; the corresponding artery is more deeply placed and does not come into view; an elevated and fringed line of the mucous membrane lies superficially to these vessels and may be followed, converging towards its fellow, almost as far as the tip of the tongue. Between the alveolar border and the tongue, on each side, is a well marked ridge of the mucous membrane, directed obliquely forwards and inwards, over the sublingual salivary gland. Each ridge ends close to the middle line in a small papilla, and on this is seen, in the form of a minute spot, the opening of Wharton's duct into which a fine probe may be easily passed.

On putting back the head, the mucous membrane covering the hard palate, and the soft palate come into view, as well as the uvula, the anterior and posterior pillars of the fauces, and the tonsils. The hamular process is plainly felt a little behind and internal to the last molar tooth, and just in front of this is situated the opening of the posterior palatine canal, through which the largest vessels and nerves of the palate issue. The pterygo-maxillary ligament is to be felt descending from the hamular process to the inferior maxilla, being contained in a more or less prominent fold of the mucous membrane, which passes between the jaws behind the extremities of the dental arches. Just in front of this, and immediately internal to the last molar tooth, the lingual branch of the fifth nerve runs inwards beneath the mucous membrane to the side of the tongue.

Between the posterior pillars of the fauces, a portion of the mucous lining of the hinder wall of the pharynx is seen; and if the finger be passed behind the tongue, there is no difficulty in feeling the remainder of the back of the pharynx and the epiglottis. By hooking the finger up behind the soft palate, the basilar process of the occipital bone is reached, and the posterior nares and adjacent parts may be explored. In this way also the bodies of the upper cervical vertebræ may be examined, the anterior arch of the atlas being opposite the lower margin of the posterior nares, and the axis corresponding to the soft palate.

### THE NECK.

The front of the neck is divided into an upper, *suprahyoid, submaxillary*, or *hyo-mental region*, and a lower, *infrahyoid* or *hyo-sternal region*. The hyoid bone, which forms the boundary line between the two divisions, can be felt in the receding angle below the chin, and it may be examined by fixing the two great cornua between the fingers. The anterior bellies of the digastric muscles form the convex surface in the middle of the suprahyoid region, and outside this on each side the submaxillary gland is both to be felt and seen. The median prominence (*pomum Adami*) in the upper part of the infrahyoid region is due to the thyroid cartilage, and is strongly marked in men, especially those with deep voices, small or indistinct in women and children. Above the thyroid cartilage the finger sinks into the depression (thyro-hyoid space) between that and the hyoid bone; below the thyroid, the crico-thyroid space and the cricoid cartilage are recognised; and from the latter the finger passes on to the trachea. The rings of the trachea are, however, scarcely to be distinguished, being obscured above by the isthmus of the thyroid body, and below by the muscles and the increasing quantity of fat as the airtube recedes from the surface, the depth of the front of the trachea at the upper border of the sternum amounting to nearly an inch and a half.

The lower part of the epiglottis is placed behind the thyro-hyoid space, and still farther back is the upper aperture of the larynx. The rima glottidis is at a lower level, being opposite the middle of the short anterior margin of the thyroid cartilage. The lower border of the cricoid cartilage indicates also the termination of the pharynx and the commencement of the œsophagus.

Along the side of the neck, the sterno-mastoid muscle runs obliquely from the mastoid part of the temporal bone to the sternum and clavicle; its anterior border, forming the hinder boundary of the anterior triangle of the neck, is thick and prominent, and leads down to the strongly marked sternal head, which passes to the front of the manubrium and gives rise, with its fellow of the opposite side, to the deep *suprasternal notch*. The posterior border of the muscle is thin, and in its upper part does not show on the surface; inferiorly it becomes evident and is continued into the clavicular head, which is, however, broader and l salient than the sternal origin. A slight depression usually correspo to an interval between the two heads, and the lower boundary of depression is formed by the somewhat prominent inner extremity of clavicle. A needle thrust backwards in this depression and in cont with the end of the clavicle would reach, on the right side, the bifur tion of the innominate artery, on the left, the common carotid arter it passes into the neck.

The carotid arteries are situated just beneath the border of the ster mastoid muscle, their position being indicated more exactly by a l drawn from the sterno-clavicular articulation to a point midway betw the angle of the jaw and the mastoid process. The common car artery reaches upwards as far as the upper border of the thyr cartilage; above this level, the external and internal carotids are pla side by side, the external being the more anterior, until they p beneath the posterior belly of the digastric muscle, the position of wh may be indicated by a line drawn from the mastoid process to the f part of the hyoid bone. If deep pressure be made in the situation the great vessels opposite the cricoid cartilage, the prominent anter tubercle of the transverse process of the sixth cervical vertebra (*car* *tubercle*) can be felt, and the common carotid artery may be compres against it. This is a little below the spot at which the omo-hy muscle crosses the carotid artery, and indicates also the place where t inferior thyroid artery turns inwards, and the vertebral artery usu enters upon its course through the foramina in the transverse process

The lingual artery runs forwards from the external carotid along t upper margin of the great cornu of the hyoid bone, and the hypoglos nerve takes a similar course close above the artery. At a slightly hi level, the occipital and facial arteries leave the external carotid, the for passing up to the transverse process of the atlas, which may be felt j below and a little in front of the tip of the mastoid process, the lat taking a winding course above the submaxillary gland to the ante border of the masseter muscle. The superior thyroid artery, arisi below the lingual, runs downwards and inwards near the back of t thyroid cartilage, and sends its crico-thyroid branch across the cr thyroid space.

The line of the internal jugular vein is just external to that of th carotid arteries; the facial vein, more superficial than the artery, co from the anterior border of the masseter downwards and backwards, join the main trunk about opposite the upper border of the thy cartilage; the middle thyroid vein crosses the common carotid ar near the level of the cricoid cartilage, and the large inferior thy veins are situated deeply on the front of the trachea. More super placed, and often showing through the skin, are the anterior jug vein near the middle line, and a communicating branch, fre large size, between the facial and anterior jugular veins, lying a the anterior border of the sterno-mastoid muscle. The right and anterior jugular veins are generally connected by a cross branch of siderable size at the bottom of the suprasternal notch, close to the up border of the manubrium, and the lower part of each vein is th directed outwards behind the origin of the sterno-mastoid, so that gr care must be exercised, in order not to wound the vessel, in divid this muscle for the cure of wry-neck.

The position of the tonsil corresponds externally to the angle of the jaw.

Behind the sterno-mastoid muscle, between it and the trapezius, is the intermuscular space known as the posterior triangle of the neck; inferiorly, this gives rise to a broad depression, the *supraclavicular fossa*, in which the omo-hyoid muscle and the brachial plexus may be felt, and in thin persons seen. In the angle between the sterno-mastoid and the clavicle, the third part of the subclavian artery can be felt pulsating, and the circulation in the vessel may be arrested here by pressure directed downwards and backwards against the first rib. The subclavian artery, as it crosses the root of the neck, describes a curve with the convexity upwards, having its inner end behind the sterno-clavicular articulation, its outer end beneath the centre of the clavicle, and its mid-point from half an inch to an inch above that bone. The left artery is more deeply placed at first than the right, and does not usually rise so high in the neck. The subclavian vein is placed at a lower level, and is, as a rule, entirely under cover of the clavicle. The pleura and lung ascend above the clavicle into the arch formed by the subclavian artery. The pulsation of the transverse cervical artery may frequently be distinguished a short distance above the clavicle.

The external jugular vein runs over the surface of the sterno-mastoid muscle in the direction of a line drawn from the angle of the jaw to the centre of the clavicle, and is covered only by the integument and the platysma, the fibres of the latter being nearly parallel to the course of the vein. Near the clavicle, the vein becomes considerably enlarged, being joined by some branches from the shoulder (transverse cervical and suprascapular), which, with the lower part of the trunk, generally form a more or less dense plexus over the third part of the subclavian artery.

About an inch below the tip of the mastoid process, the spinal accessory nerve passes beneath the anterior border of the sterno-mastoid; emerging at, or slightly above, the middle of the posterior border of this muscle, it then continues its oblique course across the posterior triangular space, and sinks beneath the upper border of the trapezius on a level with the sixth or seventh cervical spine; under the latter muscle, the nerve runs downwards immediately internal to the vertebral border of the scapula. The great auricular and superficial cervical nerves also come out at the posterior border of the sterno-mastoid about the middle of its length, and are thence directed, the great auricular upwards to the ear, and the superficial cervical forwards to the front of the neck.

## SUPERFICIAL ANATOMY OF THE TRUNK.

### THE CHEST.

On the front of the chest, the greater part of the thoracic wall is concealed on each side by the pectoralis major, the uppermost portion of the muscle extending over the inner half of the clavicle from which it arises, while inferiorly, it forms a prominent curved margin, which follows the direction of the fifth costal cartilage. Externally, the upper and lower borders of the muscle converge as it narrows to its insertion; the former is at first separated from the adjacent anterior margin of the deltoid by the infraclavicular fossa, but lower down the two muscles become closely united; the lower margin of the pectoralis major leaves the chest opposite the fifth rib (at which spot the lowest slip of th pectoralis minor often appears on the surface) and forms, as it pass upwards and outwards to the arm, the rounded anterior axillary fold The nipple is placed over the outer and lower part of the pectora muscle, generally between the fourth and fifth ribs, about three-quarter of an inch external to the junction of the bone and cartilage, and rathe more than four inches from the middle line; but its position varies considerably in different individuals, and it is not unfrequently, especially i fat persons and in females, at a much lower level.

Along the middle line, the sternum is subcutaneous at the bottom o the *sternal groove* or *furrow* between the great pectoral muscles. Th furrow is interrupted towards the upper part by a slight, but distinct transverse ridge, due to the manner in which the manubrium and body of the sternum are united together, and on each side of this the secon costal cartilage, which projects forwards more than the others, continue the prominence outwards. Inferiorly, the sternal furrow opens out, a the pectoral muscles diverge from one another, exposing the lower end o the body of the sternum, a spot which is always to be readily felt, an usually distinctly seen, owing to the formation of the infrasterna depression immediately below it. The *infrasternal depression* (pit of th stomach, scrobiculus cordis) is a generally well marked, althoug variable, hollow between the seventh costal cartilages and the uppe ends of the recti muscles, and is placed over the ensiform process, whic is itself seldom visible on the surface.

To the outer side of the pectoralis major, the ribs are covered by th serratus magnus. Of the digitations of this muscle, the first to appear at the lower margin of the pectoralis major, is the one attached to th fifth rib; the following one, the sixth, is the largest and mos prominent, and they become less marked below this. Below the pectora muscle, the wall of the thorax is covered by the rectus abdomin internally, and the external oblique laterally, the pointed slips of th latter muscle being received between the digitations of the serrat magnus. More posteriorly, the latissimus dorsi ascends over the hind part of the serratus, and, winding round the teres major muscle, form the thick posterior fold of the axilla.

The ribs may generally be followed without difficulty over the fr and sides of the chest; but only a very small portion of the first can distinguished, as it is almost completely covered by the clavicle a scapula. The width of the intercostal spaces, and the form of subcostal angle vary greatly in accordance with the shape of the ch Thus, in a long narrow chest the lower ribs slope very much downwa and are near to one another, the subcostal angle is narrow, and lateral margin of the thorax reaches nearly to the iliac crest. It wi remembered that the upper margin of the sternum is on a level (dur expiration) with the disc between the second and third dorsal verteb the junction of the manubrium and body is opposite the fifth dors vertebra; and the xiphi-sternal articulation generally corresponds to th lower part of the ninth dorsal vertebra.

The apex of the lung rises above the upper limit of the thorax in the neck, where it is placed behind the interval between the two hea f the sterno-mastoid muscle. The height to which it extends abo e clavicle ranges in ordinary circumstances from half an inch to a ch, but sometimes it is as much as an inch and three-quarters, wi in other cases the lung does not project at all above the bone. A resonant percussion-note may, however, be obtained in the living subject as far as three-quarters of an inch above the level of the apex, owing to the obliquity of the surface of the neck. The distance of the apex from the clavicle is actually diminished during inspiration, since that bone is then moved upwards with the anterior end of the first rib. There does not appear to be any constant difference in the extent upwards of the lung on the two sides (Pansch). From the apex, the anterior border of each lung inclines inwards behind the sterno-clavicular articulation and the manubrium, to the junction of the latter with the body of the sternum, where the two almost meet in the middle line; they then descend together, the right sometimes projecting a little to the left of the mid-line, as far as the fourth costal cartilage; from this point the margin of the right lung continues a nearly straight course to the level of the sixth chondro-sternal articulation (sometimes even to the lower end of the body of the sternum), while that of the left slopes outwards behind the fifth costal cartilage, in a direction which may be indicated with sufficient accuracy by a line drawn from the fourth chondro-sternal articulation of the left side to the spot on the chest-wall corresponding to the apex of the heart (see below).

The lower limit of the lung may be marked by a line, slightly convex downwards, carried round the side of the chest from the sixth chondro-sternal articulation to the tenth dorsal spine. In the mammary line, the lung extends downwards to the sixth rib; opposite the posterior fold of the axilla, to the eighth rib; and in the scapular line (carried vertically downwards from the lower angle of the scapula, while the arms are against the sides), to the tenth rib. This margin of the lung descends considerably in inspiration, and rises in expiration. The position of the great fissure in each lung may be ascertained approximately by drawing a line from the second dorsal spine to the sixth rib in the nipple-line; and the smaller fissure of the right lung extends from the middle of the foregoing to the junction of the fourth costal cartilage with the sternum.

The pleura reaches considerably farther downwards than the lung. Posteriorly, its lower margin corresponds most frequently to the head of the twelfth rib, or the eleventh dorsal spine; it is seldom higher than this, but often lower, in many cases extending as much as an inch beyond the spot mentioned. Being directed at first horizontally outwards, its line then ascends gradually over the side of the chest, and passes behind the seventh costal cartilage to the sternum, on the left side extending considerably farther over the pericardium than the corresponding lung. At the side of the chest, the line of reflection of the pleura is generally from two to three inches above the lower margin of the thorax: towards the front, it is usually a little lower on the left side than the right.

The upper limit of the heart is represented by a horizontal line at the level of the second costal cartilages; the lower limit by a line drawn somewhat obliquely, and with a slight downward convexity, from the junction of the seventh costal cartilage of the right side with the sternum to the apex, the latter point being in the fifth intercostal space, about three and a half inches to the left of the middle line, and generally about an inch and a half below, and three-quarters of an inch to the sternal side of, the nipple. The right border of the heart is indicated by a line carried from the second to the seventh chondro-sternal articulation, and arching out-

wards to a distance of one inch and a half from the middle line; the l
border, by an oblique line, convex upwards, extending from the seco
left costal cartilage to the apex. The area thus marked out correspon

Fig. 368.

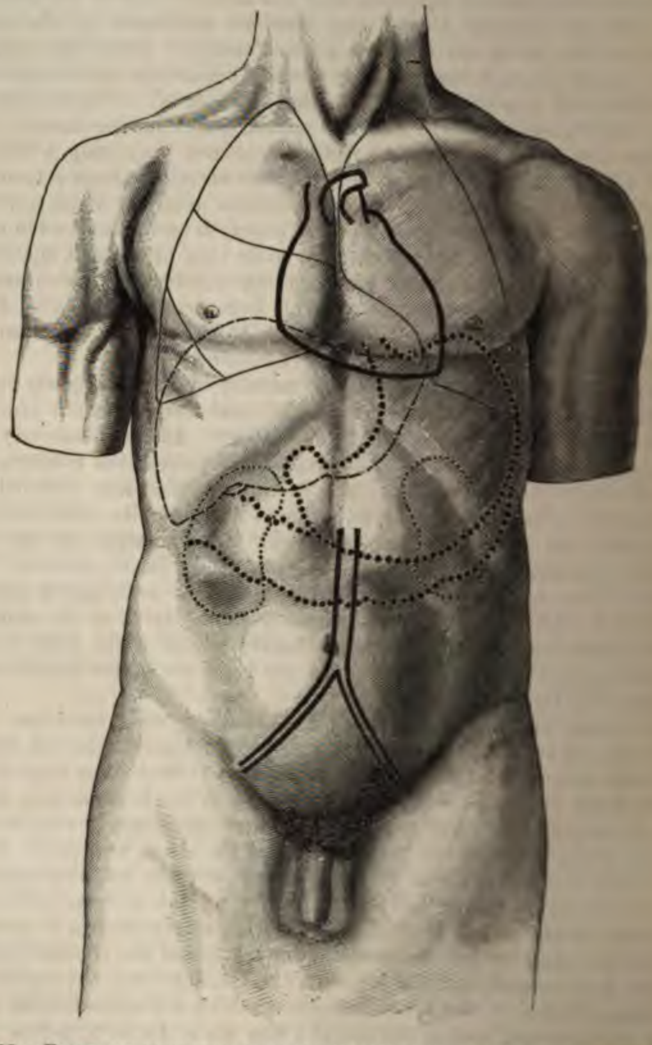

Fig. 368.—FRONT VIEW OF THE TRUNK, SHOWING THE RELATIVE POSITIONS OF TH PRINCIPAL THORACIC AND ABDOMINAL VISCERA, &c. (from a drawing by R. J. Gal (G. D. T.) ½

The outlines of the lungs and their large fissures are indicated by thin lines; the p tion of the heart and great vessels (superior vena cava, arch of aorta and pulm artery), as well as below the abdominal aorta and the common and external iliac arte by thick lines; the liver is represented by a broken line; the stomach and trans colon by thick dotted lines; and the kidneys by thin dotted lines.

to what is known as the *deep cardiac dulness*, although the latter can hardly be traced above the third costal cartilages; the *superficial cardiac dulness* corresponds to that part of the heart which is uncovered by lung, and thus begins at the inner end of the fourth left cartilage, extends to the left almost to the apex, to the right as far as the middle line, and below merges into the dulness which answers to the liver.

The pulmonary orifice is placed opposite the upper margin of the third left costal cartilage, close to the sternum, whence the artery proceeds upwards to its bifurcation behind the second costal cartilage of the same side, which is therefore termed the *pulmonary cartilage*. The orifice of the aorta is below and a little internal to the pulmonary orifice, being behind the sternum, close to the lower border of the third left cartilage; from this spot the ascending part of the arch passes across to the right edge of the sternum opposite the second (*aortic*) cartilage, and the transverse part then returns to the left side, crossing the middle line about an inch from the suprasternal depression. Opposite the middle point of the manubrium, the innominate and left common carotid arteries are arising close together from the upper border of the arch of the aorta, and they pass symmetrically upwards, the innominate to the back of the right, and the carotid to the back of the left sterno-clavicular articulation. The superior vena cava lies to the right of the arch, behind the inner ends of the first and second intercostal spaces; and the left innominate vein, resting on the upper border of the arch, is just below the upper margin of the sternum. It sometimes happens, however, especially in children, that the arch of the aorta is placed at a higher level than usual, and then the left innominate vein projects upwards into the neck. In other cases the innominate artery is longer than usual, and may be felt pulsating in the suprasternal fossa.

The auriculo-ventricular openings of the heart are lower down than the arterial orifices, being behind the sternum, the left opposite the fourth costal cartilage, the right opposite the fourth interspace.

The internal mammary artery descends behind the costal cartilages, and across the inner ends of the upper six intercostal spaces, about half an inch from the margin of the sternum; and there is occasionally another considerable artery running downwards on the inner surface of the ribs along the side of the thorax (p. 401). The intercostal vessels are lodged for the greater part of their extent in the grooves beneath the lower edges of the ribs, by which they are thus protected.

## THE ABDOMEN.

The superficial limits of the abdomen are formed above by the lower margin of the thorax, and below by Poupart's ligament and the iliac crest on each side, the former corresponding to the curved inguinal furrow. The abdominal cavity, however, extends considerably beyond these limits, both upwards into the vault of the diaphragm, under cover of the lower ribs and their cartilages, and downwards into the hollow of the pelvis. The abdomen is arbitrarily divided into nine regions by two horizontal and as many vertical lines. The horizontal lines are drawn, one at the level of the lowest part of the wall of the thorax on each side, and the other between the highest points of the iliac crests: the vertical lines pass upwards on each side from the middle of Poupart's ligament. Of the spaces bounded by these lines, the three central ones are called respectively, from above downwards, *epigastric*, *umbilical*, and *hy* *gastric*, and the lateral ones, right and left *hypochondriac*, *lum*

Fig. 369.

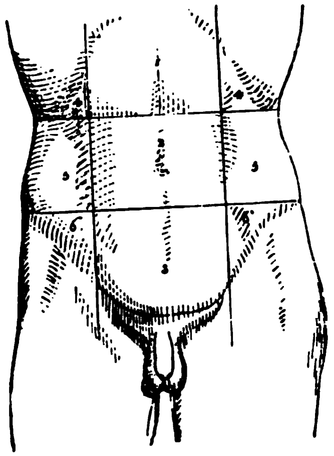

Fig. 369.—OUTLINE OF THE FRONT THE ABDOMEN, SHOWING THE DIV INTO REGIONS.

1, epigastric region ; 2, umbilic hypogastric ; 4, 4, right and left chondriac ; 5, 5, right and left lu 6, 6, right and left iliac.

and *iliac*. The lowest porti the hypogastric region, covered with hair, is also re to as the *pubes* or *pubic* and the adjacent parts of th and hypogastric regions to constitute what is known *inguinal region* or the *groin*.

The viscera which are con in the several regions are in the following table :—

| | |
|---|---|
| Epigastric region ...... | The greater part or the whole of the left lo part of the right lobe of the liver. with th bladder. part of the stomach including both the first and second parts of the duodenum. t creas. upper or inner end of the spleen. part kidneys. and the suprarenal capsules. |
| Hypochondriac. right... | The greater part of the right lobe of the li hepatic flexure of the colon. and part of th kidney. |
| Hypochondriac. left ... | Part of the stomach. with the greater po the spleen and the tail of the pancreas. the flexure of the colon. part of the left kidn sometimes a part of the left lobe of the liver. |
| Umbilical ................ | The greater part of the transverse colon. t part of the duodenum. some convolutions of num and ileum. with portions of the mese great omentum. and part of both kidneys. |
| Lumbar. right............ | The ascending colon. part of the right kid part of the ileum. |
| Lumbar. left ............ | The descending colon. part of the left kid part of the jejunum. |
| Hypogastric ............ | The convolutions of the ileum. the bl children. and if distended in adults also. t when in the gravid state. and behind. the flexure and upper part of the rectum. |
| Iliac, right .............. | The cæcum with the vermiform appendag termination of the ileum. |
| Iliac, left................. | The sigmoid flexure of the colon, convol the jejunum and ileum. |

The wall of the abdomen is formed at the front and sides muscles, and the forms to be recognised on the surface are for part to be referred to these. Anteriorly, the rectus muscle ex each side of the middle line from the pelvis to the thorax, its tendinous inscriptions producing transverse furrows, of which two are commonly to be recognised, one opposite, or just below, the tip of the ensiform process, and the other about midway between this and the umbilicus. Between the two recti is a median groove (*abdominal furrow*) continued downwards from the infrasternal fossa, along the surface of the linea alba, as far as, or a little beyond, the umbilicus, where it gradually disappears owing to the approximation and eventual union of the muscles of the two sides. The lower ends of the recti are concealed by a small accumulation of fat.

The position of the umbilicus is subject to considerable variation, but it is always below the centre of the distance between the xiphi-sternal articulation and the symphysis pubis. It is generally a little (half an inch to an inch) above the highest point of the iliac crest, and about opposite the disc between the third and fourth lumbar vertebræ.

The convex surface of the side of the abdomen is formed by the fleshy part of the external oblique muscle, and between this and the outer edge of the rectus there is a shallow depression over the upper portion of the linea semilunaris : this depression terminates above, at the margin of the thorax, in a somewhat triangular fossa, the upper boundary of which is formed by the rounded ninth costal cartilage.

In the inguinal region, the external abdominal ring is placed immediately above and external to the spine of the pubis, which can always be readily felt, as well as the common attachment of the outer pillar of the ring and Poupart's ligament. By invaginating the scrotum at some distance from the aperture, the finger may be passed through the ring into the lower part of the inguinal canal. The internal or deep abdominal ring is situated about half an inch above Poupart's ligament, opposite a spot midway between the anterior superior iliac spine and the symphysis pubis ; and the deep epigastric artery runs upwards close to the inner side of this opening, in the direction of a line inclining inwards towards the umbilicus. If the inguinal canal has been enlarged by the presence of an old hernia, the rings are almost opposite to one another, and the finger may be passed through them and can explore the surrounding parts in the interior of the abdomen.

The superficial epigastric vein is often seen through the skin, and it may frequently be observed to communicate with another vein that passes up into the armpit to join the axillary vein, especially if there be any obstruction to the return of the blood through the inferior vena cava.

The liver, which occupies the whole of the arch of the diaphragm on the right, as well as a small part on the left side, is placed for the most part under cover of the ribs. In the right hypochondriac region, its lower margin just corresponds to the lower border of the thorax, but in the epigastric region, a part of both right and left lobes comes into contact with the abdominal wall ; the margin of this part runs obliquely across the subcostal angle from the ninth right to the eighth left costal cartilage, and crosses the middle line about a hand's breadth below the xiphi-sternal articulation. The gall-bladder projects beyond this margin opposite the ninth costal cartilage, and close to the outer edge of the rectus muscle. The extent of the liver upwards, if traced on the surface of the body, is indicated by a line crossing the mesosternum close to its lower end, and rising on the right side to the level of the fifth chondro-

sternal articulation, on the left to that of the sixth ; it does not usual
reach more than an inch and a half or two inches beyond the left marg
of the sternum. It must be borne in mind, however, that the liver
subject to great variations, not only in size, but also in position, both te
porarily and permanently. Thus, it sinks with inspiration, and rises
expiration ; it descends slightly on assuming the upright position : a
it is frequently moved downwards by alterations in the shape of t
chest. It is relatively very large in the infant and child, and exten
across far into the left hypochondriac region. In adults, the margin
the liver is seldom to be felt below the ribs on the right side duri
health, unless the abdominal wall be unusually thin.

The stomach lies in the left hypochondriac and the epigastric regio
in the latter being partly covered by the liver and partly in contact wi
the abdominal wall. Its cardiac orifice is situated behind the seven
costal cartilage of the left side, about an inch from the sternum : t
pylorus is from two to three inches below the xiphi-sternal articulati
and, when the stomach is contracted, immediately to the right of t
mesial plane ; but when the stomach is distended, the pylorus mo
considerably to the right. The fundus of the stomach is direct
upwards into the left portion of the vault of the diaphragm, and reac
under ordinary circumstances to the level of, or somewhat higher tha
the sixth chondro-sternal articulation, being a little above (and behin
the apex of the heart. The great curvature of the stomach is direc
at first to the left, and afterwards downwards, the latter part reachin
with a moderate degree of distension of the organ, about as far as t
line separating the epigastric from the umbilical regions.

The transverse colon passes across in the upper part of the umbili
region, following closely the great curvature of the stomach. T
caecum is comparatively superficial in the right iliac region : t
ascending colon and the hepatic flexure are deeply placed in the ri
lumbar and hypochondriac regions. The splenic flexure reaches
much higher level than the hepatic, and is situated behind the stoma
in the left hypochondriac region, while the descending colon occup
the hinder part of the left hypochondriac and lumbar regions. De
pressure on the left side detects the sigmoid flexure as it passes over t
brim of the pelvis, in thin persons even when comparatively empty :
distended with faeces, it forms a distinct tumour in this situation.

The intestines below the stomach are all covered more or less co
pletely by the great omentum. The coils of the small intestine occu
the anterior part of the belly below the transverse colon, those of t
jejunum being principally found above, those of the ileum below.

In children under ordinary circumstances, and in adults when i
distended, the bladder rises out of the pelvis into the hypogastric regi
being closely applied to the anterior abdominal wall without the inte
vention of peritoneum for some distance above the pubis ; if t
distension be excessive, the bladder may reach as far as the umbilicus.

The kidneys, being situated at the back of the abdominal cavity, a
not to be felt under normal conditions, or at most the right is at tim
to be detected. They occupy on each side a part of the lumbar, hyp
chondriac, epigastric, and umbilical regions. The inferior extremity
the right kidney (which, it will be remembered, is the lower of the tw
scarcely reaches to the level of the umbilicus.

The pancreas crosses the spine about three inches above the umbilicus and the third part of the duodenum is placed at a lower level, reaching to within about an inch of the umbilicus.

The abdominal aorta passes downwards usually a little to the left of the mid-line of the body, although its lower end often occupies a mesial position, or may even extend over slightly to the right. The bifurcation occurs on the average about three-quarters of an inch below the umbilicus, and the direction of the common and external iliac arteries is indicated by drawing a line from this point to another midway between the symphysis pubis and the anterior superior spine of the ilium. The inferior vena cava lies just to the right of the aorta.

The cœliac axis arises opposite the lower part of the last dorsal vertebra, *i.e.*, between four and five inches above the umbilicus; the superior mesenteric artery a very little lower; the two renal arteries about three and a half inches, and the inferior mesenteric about one inch above the umbilicus.

## THE BACK.

At the back of the neck, a slight mesial depression, commencing immediately below the external occipital protuberance, descends over the ligamentum nuchæ, between the prominences formed by the complexus and trapezius muscles of the two sides. By pressing deeply in this furrow, the spine of the axis is readily felt, and generally also the spines of the third, fourth, fifth, and sixth vertebræ less distinctly. The furrow disappears gradually towards the root of the neck, where the spines of the seventh cervical and upper one or two dorsal vertebræ become visible. The first spine to appear is usually that of the seventh cervical vertebra, but sometimes the sixth is long and comes to the surface: the most prominent is the first dorsal. They necessarily project more plainly when the neck is inclined forwards. Below these, the long *spinal furrow* descends in the middle line between the elevations formed by the erector spinæ muscles covered above by the trapezius and below by the latissimus dorsi. The furrow is deepest in the lower dorsal and upper lumbar regions, where the muscles are thickest and most fleshy; in the lower lumbar region and over the upper part of the sacrum, the erector muscles are tendinous, and give rise to a somewhat lozenge-shaped flattened area through which the groove is continued, becoming gradually shallower, to terminate at the spine of the third piece of the sacrum (last sacral spine) in the angle formed by the meeting of the right and left gluteus maximus muscles. A little above and external to the latter point, a slight depression indicates the position of the posterior superior iliac spine. At the bottom of the spinal furrow, the spines may be felt and counted, the middle dorsal ones generally with considerable difficulty in the erect position, but most of them are rendered very evident by bending the column forwards. The fourth lumbar spine is on a level with the highest part of the crest of the ilium.

The spine of the scapula is easily felt beneath the skin, and may be traced outwards (very little upwards when the arm is hanging) to the acromion, which is represented on the surface by a depression in a muscular subject, or when the arm is raised. The lower border of the spine and the outer border of the acromion meet in a prominent angle, which is always to be distinctly recognised on the surface; from this point measurements of the length of the arm are most conveniently taken. The vertebral border and the inferior angle of the scapula are seen, although covered for the most part by muscles, the former by the trapezius, the latter by the latissimus dorsi. The superior border cannot usually be distinguished, but the axillary border can be felt more or les distinctly through its thick muscular covering. With the arms hanging by the side, the upper angle of the scapula corresponds to the upper border of the second rib, or the interval between the first and second dorsal spines; the lower angle to the seventh intercostal space (sometimes the eighth rib) or the interval between the seventh and eighth dorsal spines; and the root of the spine of the scapula to the interv between the third and fourth dorsal spines. The vertebral border o the bone is at the same time nearly but not quite perpendicular, i lower end being inclined a little outwards.

At the inner end of the spine of the scapula, a slight depression i dicates the triangular tendon in which the lower fibres of the trapezi end; and a slight groove, which is seen at times passing upwards a outwards over the surface of the eminence formed by the erector spin in the direction of a line from one of the lowest dorsal spines to th triangular tendon, marks the lower edge of the muscle. Immediate above the spine of the scapula is a convex surface formed by the thick part of the trapezius covering the supraspinatus muscle; and above th the sloping surface leading down from the neck to the shoulder is form by the upper part of the trapezius, supported by the levator ang scapulæ and by fat.

The lower ribs are to be felt through the latissimus dorsi, outside t edge of the erector spinæ; but it must be borne in mind that the twel rib is often very short and does not project beyond the margin of t erector muscle, so that the lowest rib that can then be felt is the elevent The ribs should, therefore, always be counted from above downwards, a not from below upwards.

The lower end of the larynx and pharynx, and the commencement the trachea and œsophagus are about on a level with the interv between the sixth and seventh cervical spines. From this spot t trachea descends in the middle line, and divides opposite the fourt dorsal spine into the two bronchi, which are thence directed outwards a downwards, the right more transversely than the left.

The apex of the lung, corresponding to the neck of the first ri extends up to the level of the seventh cervical spine. Mesially, t lungs touch the sides of the bodies of the vertebræ; and inferiorly, the reach down to the tenth dorsal spine, the pleura to the eleventh or eve lower, as has already been described (p. 675).

The œsophagus, from its commencement, inclines at first somewhat the left, but regains the middle line about the fifth dorsal vertebra; i its lower part it is deflected more considerably to the left, and it term nates at the cardiac orifice of the stomach on a level with (or a little abov the ninth dorsal spine. The pyloric orifice of the stomach is to th right of the twelfth dorsal spine.

The arch of the aorta reaches the left side of the vertebral colum just above the fourth dorsal spine, and the descending aorta pass downwards, gradually inclining to the front of the column, to bifurcat at a spot in, or close to, the middle line, on a level with the fourth lumb spine. The cœliac axis arises opposite the twelfth dorsal, the ren arteries opposite the first lumbar spine.

The convex surface of the spleen looks backwards and somewhat out

Fig. 370.

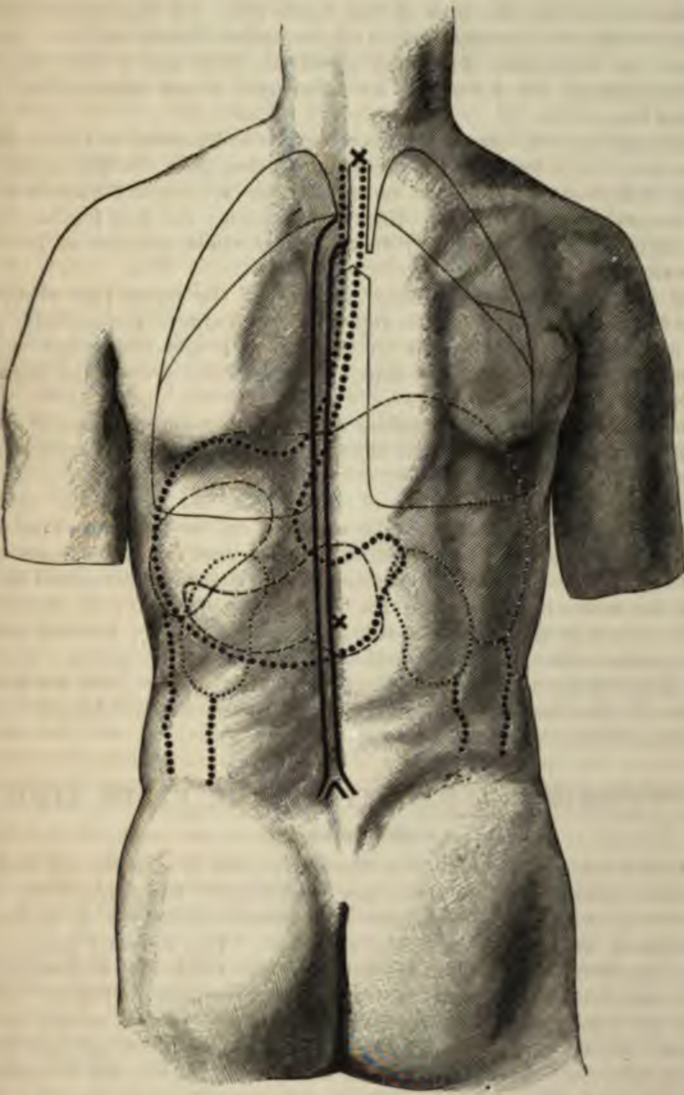

Fig. 370.—Posterior view of the trunk, showing the relative positions of the principal thoracic and abdominal viscera, &c. (from a drawing by R. J. Godlee). (G. D. T.) ⅓

The several objects are indicated in the same manner as in fig. 368, the trachea and lungs by thin lines, the aorta by thick lines, the liver, pancreas and spleen by broken lines, the œsophagus, stomach, ascending and descending colon by thick dotted lines, and the kidneys by thin dotted lines ; ×, ×, seventh cervical and first lumbar spines.

wards. It is placed beneath the ninth, tenth and eleventh ribs of the left side, being separated from them by the diaphragm, and at its upper part also by the lung. It lies very obliquely, its long axis coinciding almost exactly with the line of the tenth rib. Its highest and lowest points are on a level respectively with the ninth dorsal and first lumbar spines; its inner end is distant about an inch and a half from the median plane of the body, and its outer end about reaches the mid-axillary line.

The upper end of the left kidney reaches to the level of the eleventh dorsal spine; the lower end is nearly two inches from the iliac crest, and a little below the level of the second lumbar spine; the hilus is about two inches from the middle line, and opposite the first lumbar spine. The right kidney is generally from half to three-quarters of an inch lower than the left.

The ascending and descending portions of the colon pass vertically along the outermost part of the right and left kidneys respectively; the part of the intestine which is in contact with the abdominal wall is placed immediately behind a line carried vertically upwards from the central point of the iliac crest.

The pancreas crosses the spinal column opposite the twelfth dorsal and first lumbar spines, and the third part of the duodenum immediately below the latter.

The relation of the origins of the spinal nerves to the spinous processes of the vertebræ may be summed up as follows.—The eight cervical nerves occupy the part of the spinal cord from its commencement to the level of the sixth cervical spine; the upper six dorsal nerves, from the seventh cervical to the fourth dorsal spine; the lower six dorsal nerves, from the fifth to the tenth dorsal spine; the five lumbar nerves arise opposite the eleventh and twelfth dorsal spines; and the five sacral nerves correspond to the first lumbar spine. (See, for further details, W. R. Gowers, "The Diagnosis of Diseases of the Spinal Cord," London, 1880, p. 6.)

## SUPERFICIAL ANATOMY OF THE UPPER LIMB.

### THE SHOULDER.

In the region of the shoulder, the outer part of the clavicle and the acromion process of the scapula can be distinctly felt beneath the skin, and the extremity of the former bone usually gives rise to a marked elevation at its junction with the acromion. The rounded prominence of the shoulder is formed immediately by the thick deltoid muscle, but it is also due in great measure to the large upper extremity of the humerus, which can be felt moving under the muscle as the arm is rotated. Close to the inner side of the shoulder-joint, and just below the clavicle, the coracoid process is to be recognised; and by pressing deeply in the axilla when the arm is abducted, the lower margin of the glenoid cavity and the head of the humerus are also to be felt.

The adjacent margins of the deltoid and pectoralis major are closely united together at their lower parts, so that the division between the two muscles is not indicated on the surface; but superiorly, they are separated by a triangular interval of variable breadth, which gives rise to the well marked *infraclavicular fossa*. By pressing deeply in this fossa, the axillary artery may be compressed against the second rib. The back of the shoulder is flattened, and sloped from within outwards and a ittle forwards, owing to the oblique position of the scapula; and the hinder portion of the deltoid, which is thinner than the anterior, is tendinous at its origin, and adheres closely to the subjacent infraspinatus muscle, so that the upper part of its margin is not indicated upon the surface. The infraspinatus is continued into the teres minor, and below the latter muscle is the thick teres major, with the latissimus dorsi winding round it, forming the posterior fold of the axilla. When the arm is abducted, the middle portion of the deltoid, being brought into action, is seen to present an irregular surface, the prominences corresponding to the separate fleshy portions of the muscle, and the depressions to the tendinous septa extending downwards from the acromion.

The course of the axillary artery is marked upon the surface by a line drawn from the mid-point of the clavicle to the inner border of the elevation formed by the coraco-brachialis muscle (see below). If the limb be raised from the side, the third part of the artery may be felt pulsating beneath the integument and fascia (the vein intervening) as it passes into the arm, being placed at the junction of the anterior and middle thirds of the space between the axillary folds. The artery may be readily compressed here against the humerus. The posterior circumflex vessels and the circumflex nerve are winding round the back of the humerus under cover of the deltoid, at the junction of the upper and the middle thirds of the muscle.

## THE ARM.

The shaft of the humerus is for the most part thickly covered by the muscles of the arm, and can only be felt with difficulty; but just below the insertion of the deltoid the bone comes nearer to the surface, and from this spot the outer border, or the external supracondylar ridge, can be followed down to the outer condyle, along the bottom of a furrow over the external intermuscular septum, between the supinator longus and triceps muscles. The internal supracondylar ridge is less prominent, and not so readily felt.

Along the fore and inner part of the arm (when hanging naturally by the side) is the eminence formed by the biceps muscle, extending, with a slight inclination outwards below, from the anterior margin of the axilla to the elbow. Superiorly, this is continued into a narrow elevation produced by the coraco-brachialis muscle, which issues from between the anterior and posterior axillary folds. Two depressions, the *inner* and *outer bicipital furrows*, are found on the inner and outer side respectively of the prominence of the biceps; along the outer of these the cephalic vein may generally be seen ascending beneath the skin; in the inner, which is better marked, are placed the basilic vein (in its lower half or less superficial to the fascia), the brachial vessels and the median nerve. The brachial artery is usually overlapped to a greater or less extent by the margin of the biceps, but it can be felt pulsating throughout. Pressure should be applied to the vessel from within outwards in the upper half of the arm, from before backwards in the lower.

On the outer side of the biceps, a portion of the brachialis anticus comes to the surface, and beyond that the supinator longus and extensor carpi radialis longior form a prominence which descends to the forearm in front of the external condyle; the supinator muscle shows very wards. It is placed beneath the ninth, tenth and eleventh ribs of the left side, being separated from them by the diaphragm, and at its upper part also by the lung. It lies very obliquely, its long axis coinciding almost exactly with the line of the tenth rib. Its highest and lowest points are on a level respectively with the ninth dorsal and first lumbar spines; its inner end is distant about an inch and a half from the median plane of the body, and its outer end about reaches the mid-axillary line.

The upper end of the left kidney reaches to the level of the eleventh dorsal spine; the lower end is nearly two inches from the iliac crest, and a little below the level of the second lumbar spine; the hilus is about two inches from the middle line, and opposite the first lumbar spine. The right kidney is generally from half to three-quarters of an inch lower than the left.

The ascending and descending portions of the colon pass vertically along the outermost part of the right and left kidneys respectively; the part of the intestine which is in contact with the abdominal wall is placed immediately behind a line carried vertically upwards from the central point of the iliac crest.

The pancreas crosses the spinal column opposite the twelfth dorsal and first lumbar spines, and the third part of the duodenum immediately below the latter.

The relation of the origins of the spinal nerves to the spinous processes of the vertebræ may be summed up as follows.—The eight cervical nerves occupy the part of the spinal cord from its commencement to the level of the sixth cervical spine; the upper six dorsal nerves, from the seventh cervical to the fourth dorsal spine; the lower six dorsal nerves, from the fifth to the tenth dorsal spine; the five lumbar nerves arise opposite the eleventh and twelfth dorsal spines; and the five sacral nerves correspond to the first lumbar spine. (See, for farther details, W. R. Gowers, "The Diagnosis of Diseases of the Spinal Cord," London, 1880, p. 6.)

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On the outer side of the biceps, a portion of the brachialis anticus comes to the surface, and beyond that the supinator longus and extensor carpi radialis longior form a prominence which descends to the forearm in front of the external condyle; the supinator muscle shows very plainly if the elbow be forcibly flexed with the hand in a state of semi-pronation. On the inner side of the biceps, in the lower part of the arm a smaller portion of the brachialis anticus is superficial, and between this and the triceps, the internal intermuscular septum can be felt, with th ulnar nerve close behind it, descending to the internal condyle.

The form of the back of the arm is determined by the triceps muscle the three heads of which, together with the large tendon of insertion, ar to be recognized when the muscle is called into play. The inner head is the least distinct; the outer head forms a large prominence immediately below the hinder border of the deltoid; the long head can be seen issuing from between the teres major and minor muscles, and descending along the middle of the back of the arm; while the tendon is represented by a depressed area, leading down to the olecranon process of the ulna The musculo-spiral nerve begins to incline backwards immediately below the posterior fold of the axilla, and crosses the back of the humerus obliquely from within outwards in its middle third, being covered by th triceps muscle, and accompanied by the superior profunda vessels. At, or a little above, the junction of the middle and lower thirds of the arm the nerve perforates the external intermuscular septum, and it then descends in front of the outer supracondylar ridge to the level of the external condyle, where it divides into the radial and posterior interosseous nerves. The former takes a straight course downwards to join the artery of the same name below the elbow; but the posterior interosseous is directed backwards across the outer side of the radius in its upper fourth, to gain the back of the forearm.

### THE ELBOW.

At the elbow, the internal and external condyles come to the surface, and also the olecranon process of the ulna. The internal condyle, which, it will be remembered, is directed more backwards than inwards, is very prominent, and forms one of the most important bony landmarks of the limb The external condyle, together with the common tendon of the extensor muscles of the forearm, gives rise, when the joint is extended, to a well-marked depression at the outer and back part of the elbow, between the supinator longus and extensor carpi radialis longior muscles externally, and the anconeus internally. If the elbow be semi-flexed, the condyle is slightly prominent; and in extreme flexion, the outer part of the triceps muscle is stretched over the capitellum of the humerus, which forms a rounded eminence to the outer side of the point of the elbow (olecranon), while the condyle itself is no longer visible. The olecranon is subcutaneous at its posterior surface, its upper end being entirely covered by the insertion of the triceps; its appearance necessarily varies with the position of the joint, as does also the distance between the process and the shoulder. A bursa is interposed between the bone and the skin.

At the bend of the elbow, the subcutaneous veins are more or less distinctly visible, according to the quantity of subcutaneous fat;—the median vein bifurcating into the median-basilic and median-cephalic, which join respectively the ulnar and radial veins to form the basilic and cephalic (p. 510). The median-basilic and median-cephalic veins, diverging from each other, pass upwards on either side of the biceps tendon, which is seen, when the elbow is bent, descending from the lower end of the muscular belly into the interval between the two masses f forearm muscles. The sharp upper edge of the bicipital fascia may also be felt, and, when the muscle is forcibly contracted, seen, as it passes downwards and inwards between the median-basilic vein and the lower part of the brachial artery.

## THE FOREARM.

From the olecranon, the sinuous posterior border of the ulna is to be followed down the forearm, corresponding to a superficial furrow between the ulnar flexor and extensor muscles of the wrist; the border becomes rounded off in the lower third, but a narrow strip of the bone is still subcutaneous, leading down to the styloid process. When the hand is supinated, the styloid process of the ulna is exposed at the inner and posterior part of the wrist; but if the hand be pronated, then the skin is stretched over the opposite (outer) part of the head of the fixed ulna, which projects between the extensor carpi ulnaris and extensor minimi digiti muscles. Close below the outer condyle of the humerus, the head of the radius may be felt moving beneath the muscles as the forearm is alternately pronated and supinated. The upper half of the shaft of the radius is too thickly covered by muscles to be distinctly made out; the lower half is nearer to the surface, and can be readily examined between and through the surrounding muscles and tendons; at the lower end, the styloid process is superficial in front and behind, being covered externally by the tendons of the extensor ossis metacarpi and primi internodii pollicis muscles; and the prominent outer edge of the groove for the extensor secundi internodii pollicis is also to be distinguished.

Along the inner and fore part of the forearm, is the prominence formed by the pronato-flexor muscles, the great mass covering the ulna internally being formed by the flexor profundus digitorum beneath the flexor carpi ulnaris. A short distance below the internal condyle, a slight groove runs obliquely downwards and inwards across the muscles, caused by the prolongation of the fibres of the bicipital fascia. Near the wrist, the tendon of the flexor carpi ulnaris can be felt, passing down to the pisiform bone, and immediately external to the tendon the beating of the ulnar artery is perceptible. About the centre of the front of the wrist, the tendon of the palmaris longus descends, being the most prominent of all the tendons here, and a little external to this, the tendon of the flexor carpi radialis is also visible. Outside the latter is a hollow in which the radial vessels are placed, and where the pulse is commonly felt: immediately internal to the tendon of the flexor carpi radialis, lies the median nerve.

Along the outer border of the forearm, the long supinator and radial extensor muscles of the wrist descend, becoming tendinous and smaller below the middle; and in the lower third of the forearm a smaller prominence, directed obliquely downwards, outwards and forwards, results from the presence of the extensor muscles of the thumb crossing over the long tendons. On the back of the forearm are the extensors of the fingers, the extensor carpi ulnaris, and the anconeus, all of which may be individually distinguished in thin persons.

Numerous cutaneous veins are seen on the forearm, arising principally from the network on the dorsum of the hand, and forming two main trunks, the posterior ulnar and the radial, which ascend respectively along the inner and outer borders of the limb, and incline forwards to their termination in front of the elbow; although in many cases another large vein is present (assisting or even replacing the radial vein), which

turns round the outer border of the forearm below the middle t
the median vein. The subcutaneous veins of the lower part of the
of the forearm (also those of the palm) are small, and terminate i
median and anterior ulnar veins. It occasionally happens tha
ulnar artery, having been derived from the brachial at a higher
than usual, descends over the pronato-flexor muscles to the wrist, a
that case it would be felt pulsating beneath the skin in the neighbou
of the anterior ulnar vein (p. 420).

The bifurcation of the brachial artery takes place opposite a
a finger's breadth below the centre of the bend of the elbow.
this point, the radial artery runs downwards with a straight cou
the fore part of the styloid process of the radius, being covered b
supinator longus as far as the centre of the forearm, and super
beyond this spot. The ulnar artery inclines, with a slightly c
course, inwards to the middle of a line drawn from the internal co
of the humerus to the outer side of the pisiform bone : this line
cates in its whole extent the direction of the ulnar nerve in the fore
in its lower half that of the ulnar artery also. The latter is d
placed beneath the muscles arising from the internal condyle till wi
an inch of the wrist.

### THE WRIST AND HAND.

At the front of the wrist, on the inner side, the pisiform bone ca
grasped between the fingers, and moved slightly from side to s
below this the hook of the unciform bone can be felt with diffic
On the outer side, a projection is felt just below and internal to
styloid process of the radius, formed by the tubercle of the scap
bone, and close below this, the ridge of the trapezium is also to be
tinguished. At the back of the wrist, on the inner side, the pyram
bone can be felt, and slightly external to the middle line of the han
a prominence, sometimes indistinct, but often very well marked, f
by the base of the third metacarpal bone.

The sesamoid bones of the thumb can be felt, and the metaca
bones and phalanges can be distinctly followed on the dorsal aspect.

At the outer side of the wrist, when the thumb is extended, there
deep hollow bounded by the prominent tendons of the extensor o
metacarpi and extensor primi internodii pollicis anteriorly and the
tensor secundi internodii pollicis posteriorly ; the latter tendon may
followed down over the metacarpal bone of the thumb almost to its
sertion. Beneath these tendons, and across the intervening hollow.
radial artery runs in its course from the front to the back of the wr
its direction may be marked by a line drawn from the fore part of
styloid process of the radius to the upper end of the first interosse
space ; and a considerable vein, ascending from the outer part of
hand, is usually to be seen through the skin over the position of
artery.

On the back of the hand, the tendons of the extensor communis di
torum and extensor minimi digiti may all be recognized, together w
the connecting band between the innermost slip of the common exten
and the outer portion of the little finger tendon. Between the first a
second metacarpal bones is the abductor indicis muscle, which form
well marked prominence when the thumb is brought to the side of t
index finger, and below this is the adductor pollicis muscle contained

the fold of skin passing across between the thumb and the outer margin of the palm.

The palm of the hand is concave in the centre, where the skin is tightly adherent to the palmar fascia, and raised on each side. The outer elevation (*thenar*) is formed by the short muscles of the thumb; the inner (*hypothenar*) by the short muscles of the little finger. From the central hollow of the palm a slight groove is continued downwards to each of the fingers, corresponding to the prolongations of the palmar fascia. The palm is traversed generally by four more or less regular lines, representing the folds or "flexures" produced in the skin by the movements of the principal joints of the hand. Two of these lines are directed nearly transversely, the others longitudinally. Of the transverse lines, one commences about the junction of the upper three-fourths with the lower fourth of the inner border of the palm, and runs outwards and then downwards to the cleft between the index and middle fingers; this is caused by bending the metacarpo-phalangeal articulations of the inner three fingers; the second starts nearly opposite the foregoing, at the outer border of the hand, and is directed inwards and somewhat upwards across the middle of the palm; this results mainly from the flexion of the first joint of the index finger. The metacarpo-phalangeal articulations are placed about midway between these lines and the web of the fingers. Of the longitudinal lines, one, beginning near the centre of the wrist, curves outwards to join the upper transverse line, and is produced by the opposition of the thumb; the other runs downwards from the wrist through the centre of the palm to meet the lower transverse line opposite the middle finger, and is caused by the opposition of the fifth metacarpal bone. The four lines give rise to a figure resembling the letter M. At the wrist, two or three lines, directed rather obliquely, outwards and a little downwards, indicate the position of the principal folds formed during flexion of the joint; the radio-carpal articulation is placed about three-quarters of an inch above the lowest of these lines. There are three well-marked transverse grooves on each finger; the lower and middle ones are nearly opposite the two interphalangeal joints; the upper one, which is produced, as well as the transverse lines of the palm, by bending the metacarpo-phalangeal articulations, is placed nearly three-quarters of an inch below the joint, and on a level with the web of the fingers. On the thumb, there are only two grooves, and the proximal, which is less distinct than the other, continues upwards the line of the radial border of the index finger, thus crossing obliquely the corresponding articulation.

The web of the fingers, containing the superficial transverse ligament, limits the interdigital clefts on the palmar side; on the dorsum of the hand they are continued upwards almost to the metacarpo-phalangeal joints.

The superficial palmar arch is placed beneath the palmar fascia, a little above the centre of the palm; its position may be indicated by a line carried from the outer side of the pisiform bone downwards, and then curving outwards across the middle third of the palm on a level with the upper end of the cleft between the thumb and index finger. From the convex side of the arch digital branches proceed, one to the ulnar margin of the little finger, and three which descend opposite the intervals between the fingers and bifurcate about half an inch above the clefts. The deep palmar arch rests against the metacarpal bones about a quarter of an inch nearer the wrist than the superficial arch, and the digital branches given off by the radial artery to the thumb and ind finger are deeply placed in the palm, the collateral arteries of the thum becoming superficial at the base of the first phalanx, that of the ind finger issuing from behind the adductor pollicis. The latter branch i not unfrequently derived from the radial artery at the back of the wris and may then be felt pulsating as it descends on the posterior surfa of the abductor indicis muscle to its destination. The superficial vol artery is occasionally visible as it descends over the upper part of th thenar to the palm.

## SUPERFICIAL ANATOMY OF THE LOWER LIMB.

### THE HIP.

The region of the hip, gluteal region or buttock, extends from t subcutaneous iliac crest and the origin of the gluteus maximus mus above to the fold of the nates, produced by the thick lower margin the gluteus maximus, below. The surface is formed posteriorly by th gluteus maximus, which is generally covered by a considerable quanti of fat, and laterally by the gluteus medius, together with, at the for most part, the tensor vaginæ femoris. The latter muscle may b recognized forming a distinct prominence below the anterior part of th iliac crest, especially if the thigh be abducted or rotated inwards.

The iliac crest is represented on the surface, in muscular subjects, b a groove (*iliac furrow*), in consequence of the projection of the exter oblique muscle above, and, to a less extent, of the gluteus medius belo Traced forwards, this furrow terminates at the anterior superior ili spine, which is always easily recognized; posteriorly, the furrow beco less marked as the crest passes below the tendinous portion of t erector spinæ, but a slight depression always indicates the position of t posterior superior spine. The latter point is on a level with the spin process of the second sacral vertebra, and immediately behind the cen of the sacro-iliac articulation. From three to four inches below t iliac crest, and somewhat in front of its central point, the gr trochanter is to be felt, and in thin persons seen. The trochan projects outwards farther than the iliac crest, but it does not usua appear as a prominence on the surface owing to the great thickness the gluteus medius and minimus muscles, which occupy the holl between it and the ilium. It is entirely covered by the aponeur insertion of the upper part of the gluteus maximus, and its upp border, which is generally on a level with the centre of the hip-jo is obscured by the tendon of the gluteus medius descending to insertion on the outer side of the process. Immediately behind great trochanter is a well-marked depression, where the lower port the gluteus maximus, after passing over the ischial tuberosity, beco tendinous and sinks in to be inserted into the shaft of the femur.

Beneath the lower border of the gluteus maximus, the tuberosity the ischium is to be felt, and when the hip is flexed this process is to great extent uncovered by the muscle. A line drawn over the outer surfac of the hip from the anterior superior iliac spine to the most promin part of the ischial tuberosity is known as *Nelaton's line*, and will b found to pass over the top of the great trochanter and cross the cent of the acetabulum. It thus forms a guide to the natural position of th upper end of the femur, and is consequently of service in detect dislocations of the hip.

If a line be drawn from the posterior superior iliac spine to the outer part of the ischial tuberosity, it will cross the posterior inferior spine and the ischial spine: the posterior inferior spine is nearly two inches, and the ischial spine about four inches, below the posterior superior spine: the sciatic artery appears in the buttock at the junction of the middle and lower thirds of this line. The gluteal artery leaves the great sacro-sciatic foramen beneath a spot corresponding to the junction of the inner and middle thirds of a line drawn from the posterior superior iliac spine to the great trochanter, when the thigh is rotated inwards. Between the gluteal and sciatic arteries, the great sciatic nerve leaves the pelvis, and it thence pursues a slightly curved course to a point midway between the great trochanter and the ischial tuberosity.

## THE THIGH.

The thigh is separated from the abdomen in front by the curved inguinal furrow, at the bottom of which Poupart's ligament may be felt, more plainly in its inner than in its outer half, as it passes from the anterior superior spine of the ilium to the pubic spine: the band is relaxed, and becomes less distinct, on flexing and adducting, or rotating in, the thigh. From the pubic spine, the finger passes along the pubic crest to the front of the symphysis, and thence backwards along the inner margin of the united pubic and ischial rami to the tuberosity of the ischium, thus tracing the boundary line between the thigh and the perineum. Externally, the thigh is not definitely marked off from the region of the hip.

Immediately below Poupart's ligament, a slight hollow is generally seen, corresponding to Scarpa's triangular space (pp. 242 and 467), in which, just internal to the centre, the femoral artery may be felt pulsating. Close below the innermost part of Poupart's ligament is situated the saphenous opening in the fascia lata, its central point being about an inch and a half below and external to the spine of the pubis. Through the lower part of this aperture the internal saphenous vein passes to join the femoral trunk, and above the vein is the spot where a femoral hernia first makes its appearance on the surface of the thigh. Over and below the opening, the femoral or lower inguinal glands may usually be felt through the skin, surrounding the upper end of the internal saphenous vein.

From the apex of Scarpa's triangle a depression is continued downwards along the inner part of the thigh, between the masses formed by the quadriceps extensor muscle in front, and the adductor muscles on the inner side. The sartorius muscle lies along this depression, and may be distinctly seen when it is brought into action by raising the leg across the opposite knee. The form of the rectus muscle may be distinguished along the front of the anterior mass, and to its inner side, in about the lower half of the thigh, the vastus internus gives rise to a large prominence, increasing in size towards the knee, while on the outer side of the rectus, the vastus externus forms a broad convex surface, extending from the great trochanter above almost to the knee-joint below, and being continued backwards to the posterior aspect of the limb. The surface formed by the vastus externus is often seen to be traversed by a longitudinal groove, due to the pressure exerted by the strong ilio-tibial band of the fascia lata as it descends from the insertions of the gluteus maximus and tensor vaginæ femoris muscles to the outer tuberosity of the tibia. Of the adductor muscles, the only parts that are to separately recognised are the strong tendon of origin of the adduct longus below the pubic crest, and the lower tendon of the adduct magnus which is felt distinctly, when the knee is bent, in the interv between the sartorius and vastus internus muscles, extending down the adductor tubercle on the internal condyle of the femur. T adductors are not marked off on the surface from the hamstring gro on the back of the thigh, nor are the latter muscles to be individual distinguished from one another until they become tendinous near t knee. Along the outer and posterior part of the thigh, however, t hamstring muscles are separated from the vastus externus by a w marked groove, corresponding to the position of the external intermu cular septum.

The whole of the shaft of the femur is deeply placed, and in fair muscular subjects is not to be detected through its fleshy covering. T head of the bone is situated close below Poupart's ligament, immediate external to its mid-point, and is occasionally, in thin subjects, to be f in this position through the overlying muscles.

The subcutaneous veins of the thigh all join one trunk, the intern saphenous, which ascends from the hinder part of the inner side of t knee, with a gradual inclination forwards, to the saphenous openin The extent to which this vein and its branches are to be perceived vari greatly with the amount of subcutaneous fat.

The position of the femoral artery is indicated by a line drawn from point midway between the anterior superior spine of the ilium and t symphysis pubis to the prominent tuberosity on the inner condyle of t femur, the hip having been first slightly flexed and the thigh everte At the junction of the upper three-fourths with the lower fourth of th line, the artery passes backwards through the opening in the adduct magnus muscle. Pressure is most conveniently applied to the vessel it enters the thigh below Poupart's ligament, and it should be direct backwards so as to compress the artery against the pubis and t adjacent part of the hip-joint. Lower down, the pressure must be ma in a direction backwards and outwards, as the artery lies considerably the inner side of the shaft of the femur. At Poupart's ligament, t femoral vein is close to the inner side of the artery, and the antero- crural nerve is a little distance (a quarter to half an inch) from its out side. The profunda, arising from the main trunk usually between o and two inches below Poupart's ligament, follows a line almost identic with that of the femoral artery.

The small sciatic (posterior cutaneous) nerve lies immediately beneat the fascia along the middle line of the back of the thigh; and in t same line, but under cover of the hamstring muscles, is the great sciat nerve.

### THE KNEE.

On the inner side of the knee, the internal condyle of the femur an the corresponding tuberosity of the tibia produce a rounded surface, t most prominent point of which is formed by the tuberosity on t internal condyle. The interval between the two bones opposite the kne joint is seldom to be seen, but is always easily felt. On the upper pa of the inner condyle, the sharp adductor tubercle and the insertion of th adductor magnus tendon are also to be recognized. The extern condyle, although not prominent, is subcutaneous and readily felt; i tuberosity is comparatively little developed. The outer tuberosity of the tibia, on the other hand, forms a marked prominence at the outer and fore part of the knee, about an inch below the joint; and behind this, at a slightly lower level, the head of the fibula is distinctly felt at the outer and back part of the limb, where it generally corresponds to a depression, when the joint is extended, between the tendon of the biceps above and the peroneus longus muscle below. Anteriorly, the patella is subcutaneous, and its lateral margins are distinctly seen. When the extensor muscles are relaxed, the patella can be easily moved from side to side; but if these muscles are contracted, the patella is drawn upwards and pressed firmly against the end of the femur, and the ligamentum patellæ can then be followed down to the tubercle of the tibia: on each side of the ligament is a soft eminence produced by the infrapatellar mass of fat. When the knee is bent, the patella sinks into the hollow between the tibia and the femur, and the articular surface of the latter bone is in great part exposed; the trochlear surface can then be distinctly traced, although covered by the tendon of the extensor muscle. There are generally two bursæ, a superficial one and a deep one, over the patella, and there is frequently another over the tubercle of the tibia (p. 231).

At the back of the knee is the ham, which is marked by a deep hollow when the joint is flexed, but by a slight elevation when it is extended. On each side are the tendinous hamstrings; internally the slender semitendinosus and the stronger semimembranosus are to be recognized, as well as the gracilis a little farther forwards: externally is the thick tendon of the biceps leading down to the head of the fibula. Immediately in front of the biceps tendon, when the joint is a little bent, the upper part of the external lateral ligament is to be detected; and between this and the outer margin of the patella, the lower end of the ilio-tibial band appears as a strong cord beneath the skin, running down on the outer side of the knee to the prominent external tuberosity of the tibia; while on the inner side, the sartorius tendon, with the subjacent ones of the gracilis and semitendinosus, forms a slight elevation as it curves forwards below the inner tuberosity, to be inserted close to the tubercle of the tibia.

The external saphenous vein enters the lower part of the ham in the middle line of the limb, and perforates the fascia to join the popliteal vein; but it is not usually visible on the surface. The internal saphenous vein is generally seen on the inner side of the knee, and the nerve of the same name meets it behind the internal tuberosity.

The popliteal vessels enter the ham somewhat internal to the middle line above, and are then continued downwards over the centre of the back of the knee; the vein is more superficial than the artery, but both are very deeply placed. The upper articular vessels run transversely inwards and outwards immediately above the condyles of the femur; and the lower articular vessels are respectively just below the inner tuberosity of the tibia, and above the head of the fibula. The deep part of the anastomotic artery descends to the knee along the front of the adductor magnus tendon.

The internal popliteal nerve, continuing the direction of the great sciatic, and descending in the median line, is superficial to the vessels. The external popliteal nerve is at first under cover of the fleshy belly of the biceps, and then lies on the outer side of the ham, close behind the tendon of that muscle ; it may be felt rolling beneath the finger as it crosse the outer side of the neck of the fibula, before entering the peroneu longus muscle.

The glands in the popliteal space are not to be felt unless they ar enlarged.

### THE LEG.

Along the fore part of the leg, the anterior border of the tibia is to b followed downwards from the tubercle, constituting what is known as th shin. This border is sharp in the upper two-thirds of the leg, and describes a slight curve with the concavity outwards ; in the lower thir the border disappears, and the bone is concealed by the tendons of th anterior muscles. On the inner side of the shin, the broad intern surface of the tibia is subcutaneous below the sartorius, and leads downwards to the prominent internal malleolus. At the back of the latt process a sharp edge is felt, which is formed by the inner margin of th groove for the tendon of the tibialis posticus; the tendon itself cove the posterior surface of the malleolus. The head of the fibula is subcutaneous, as has been before mentioned ; the shaft is surrounded b muscles, but it can be felt through them in the lower half at least of th leg, and it will be remembered that it is placed considerably farther bac in the leg than the shaft of the tibia ; near the ankle, a triangul portion of the bone comes to the surface, and is continued down to th external malleolus.

Along the concavity of the anterior edge of the tibia, the prominen formed by the fleshy belly of the tibialis anticus is seen, and external this is the much less distinct and narrower extensor longus digitoru The tendons of the muscles appear in the lower third of the leg, and between them also that of the extensor proprius hallucis ; they are broug into view most distinctly by flexing the ankle and extending the toes. Fro the head of the fibula downwards, the peroneus longus and brevis musc form an elongated swelling, from which the tendons can be trac descending behind the external malleolus. Posteriorly, the elevation the calf is formed by the gastrocnemius muscle, which terminates abo the middle of the leg in the tendo Achillis ; the inner head of the gastrocnemius is the larger, and descends lower than the outer. On each side the gastrocnemius and tendo Achillis, a portion of the soleus comes the surface ; and the characteristic form of the gastrocnemius, dependin upon the peculiar structure of the muscle (p. 253), as well as the exte and shape of the projecting portions of the soleus, are brought into vie by raising the body on the toes. The tendo Achillis gradually becom narrower as it approaches the heel, but it widens again a little as it pas over the tuberosity of the os calcis to its insertion. Between it and th malleolus, on each side, is a well marked hollow, that on the outer si being the deeper ; in the inner of these, the tendons of the tibialis posticus and flexor longus digitorum, and the posterior tibial vessels an nerve are superficial.

Both the external and internal saphenous veins are visible beneath th skin of the leg, together with numerous tributaries and communicatin branches. The internal is the larger, and, after crossing in front of th internal malleolus, runs upwards just behind the inner border of th tibia ; the external passes behind the outer malleolus and then ascend over the middle of the calf to the ham. Each vein is accompanied b the nerve of the same name.

The bifurcation of the popliteal artery takes place about two inches below the knee-joint, and on a level with the lower part of the tubercle of the tibia. The course of the anterior tibial artery is marked on the front of the leg by a line drawn from a point midway between the head of the fibula and the prominence of the outer tuberosity of the tibia to the centre of the ankle-joint. The intermuscular space in which the artery lies is also indicated by a depression which is seen at the outer border of the tibialis anticus when the muscle is called into action. The posterior tibial artery runs in the direction of a line drawn from the centre of the ham to a spot midway between the tip of the internal malleolus and the centre of the convexity of the heel; beneath this spot, the vessel divides into the internal and external plantar arteries. The posterior tibial artery is covered by the gastrocnemius and soleus for about two thirds of its length, but in the lower third it is superficial and may be felt pulsating in the interval between the tendo Achillis and the tibia. About three inches below the knee, it gives off the large peroneal branch, which follows the direction of the fibula, and terminates behind the external malleolus.

## THE ANKLE AND FOOT.

Of the two malleoli, the internal is usually the more prominent, but the external descends lower and also projects farther back, having its point, as a rule, about three-quarters of an inch nearer to the heel than that of the internal malleolus. On the dorsum of the foot, the tarsal bones are not usually to be distinguished individually, but the head of the astragalus not unfrequently forms a considerable projection when the ankle-joint is extended. Along the inner side of the foot, the tuberosity of the os calcis is first felt, and then, about an inch below the internal malleolus, the sustentaculum tali of the same bone; in front of the latter, and about an inch and a half from the malleolus, the tubercle of the navicular bone is prominent, and to it the tendon of the tibialis posticus may be followed from the back of the internal malleolus; the finger next passes over the internal cuneiform bone, and recognizes the base of the first metatarsal bone as a slightly prominent ridge; from this, the shaft of the bone may be traced forwards beneath the skin to its expanded head, below which the sesamoid bones may be felt on the plantar aspect of the metatarso-phalangeal articulation. On the outer side of the foot, nearly the whole of the external surface of the os calcis is subcutaneous, and the peroneal spine of the bone may often be felt a little below and in front of the external malleolus. The anterior extremity of the os calcis may be distinguished when the foot is inverted, forming a marked prominence above the level of the cuboid bone, and in front of this, distant about two and a half inches from the external malleolus, the projecting tuberosity at the base of the fifth metatarsal bone is easily felt.

Over the front of the ankle, the tendons of the anterior muscles of the leg are bound down by the anterior annular ligament; they can be readily distinguished when the joint is flexed, spreading over the dorsum of the foot, and disposed in the following order:—the most internal and the largest is the tibialis anticus; next comes the extensor proprius hallucis, and then the extensor longus digitorum, dividing into its four slips for the smaller toes; lastly, proceeding from the outer side of the long extensor to the base of the fifth metatarsal bone is the peroneus tertius; the last-named is, however, not unfrequently wanting. The anterior tibial vessels and nerve are placed, opposite the ankle-joint, between the tendons of the extensor proprius hallucis and extensor l digitorum. Beneath the tendons of the extensor longus digitoru the dorsum of the foot, is placed the extensor brevis digitorum, the belly of which produces a distinct swelling over the tarsal region. fleshy mass on the inner margin of the foot is formed by the ab and flexor brevis hallucis muscles; and that on the outer border abductor and flexor brevis minimi digiti. In the sole, the thick the integument, and the manner in which the parts are bound to by the strong plantar fascia, render it impossible to distingui individual muscles.

On the back of the foot, the arch or plexus of veins shows through the skin, and its extremities may be followed into the i and external saphenous veins respectively.

The dorsal artery of the foot extends from the centre of the joint to the back of the first intermetatarsal space, and it may pulsating midway between the tendons of the extensor proprius l and extensor longus digitorum. Just before its ending, it is cro the innermost slip of the extensor brevis digitorum. The e plantar artery runs from the bifurcation of the posterior tibial ( obliquely across the sole to within an inch of the tuberosity of t metatarsal bone, and then is directed more transversely inward back of the first interosseous space, where it meets the termin the dorsal artery. The internal plantar artery is much smaller t external; its position may be indicated by a line drawn from t of bifurcation of the posterior tibial to the under part of the me phalangeal articulation of the great toe.

The metatarso-phalangeal articulations are situated about a behind the web of the toes.

## ANATOMY OF THE GROIN: HERNIA

Abdominal herniæ are chiefly of three kinds, *inguinal, fe umbilical*. The last-named, however, which occurs at the um need not be more than mentioned in an anatomical work, inasmu presents relations by no means intricate. An inguinal hernia, f the course of the spermatic cord from the cavity of the abdomen femoral hernia, coming through the crural canal at the inner side femoral vessels, have important anatomical relations which m studied with the greatest attention.

### INGUINAL HERNIA

The **inguinal canal**, through which the spermatic cord pass the cavity of the abdomen to the testis, and through which an i hernia also passes, begins at the internal abdominal ring and end external one. It is oblique in its direction, being nearly par and immediately above the inner half of Poupart's ligament; measures about an inch and a half in length. The external immediately above and external to the pubic spine; the inte midway between the anterior superior iliac spine and the sym pubis, and half an inch above Poupart's ligament. In front the bounded by the aponeurosis of the external oblique muscle in its length, and at the outer end by the fleshy part of the internal also; behind it is the fascia transversalis, [illegible] the inner end, the conjoined tendon of the two deeper abdominal muscles. Above, the canal is limited by the arched lower borders of the internal oblique and transversalis muscles, while below, it is bounded by the broad surface of Poupart's ligament, which separates it from the sheath of the large blood-vessels descending to the thigh, and from the femoral canal at the inner side of those vessels. The deep epigastric artery is close to the inner border of the internal ring, and the external iliac artery is below it.

Fig. 371.

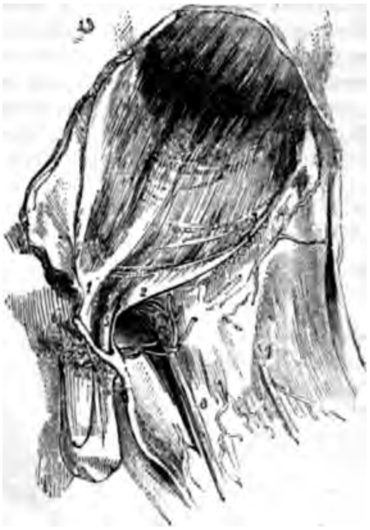


Fig. 371.—The aponeurosis of the external oblique muscle and the fascia lata. (R. Quain.) $\frac{1}{3}$

1, internal pillar of the superficial ring; 2, external pillar of the same (Poupart's ligament); 3, intercolumnar fibres of the aponeurosis; 4, pubic part of the fascia lata; 5, spermatic cord; 6, long saphenous vein; 7, iliac part of the fascia lata.

Fig. 372.

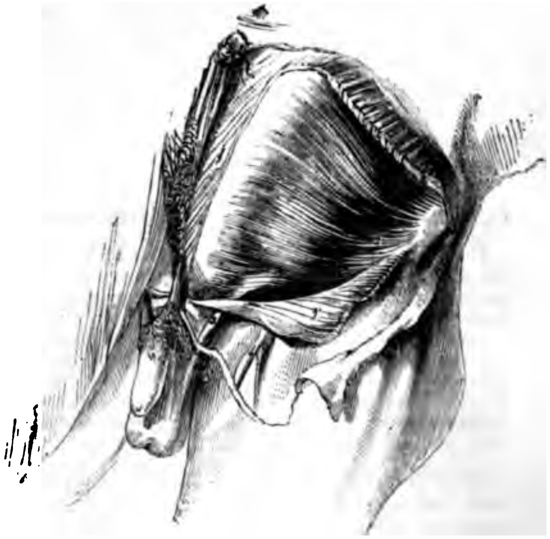


Fig. 372.—Deeper dissection of the abdominal wall in the groin. (R. Quain.) $\frac{1}{5}$

The aponeurosis of the external oblique muscle having been divided and turned down, the internal oblique is brought into view with the spermatic cord escaping beneath its lower edge: 1, aponeurosis of the external oblique: 1', lower part of the same turned down; 2, internal oblique muscle; 3, spermatic cord; 4, saphenous vein.

The spermatic cord, which occupies the inguinal canal, is composed of the arteries, veins, lymphatics, nerves, and excretory duct of the testis (vas deferens), together with a quantity of loose areolar tissue mixed up with those parts.

The coverings given from the constituent parts of the abdominal wall to the spermatic cord, besides the integuments, are, from the external ring, a prolongation of the intercolumnar or spermatic fascia; the cremasteric muscle and fascia from the lower border of the internal oblique muscle, and a thin, funnel-shaped prolongation of the transversalis fascia from the edge of the inner ring (infundibuliform fascia). Beneath the last, the areolar tissue uniting together the constituents of the cord is continuous with the subperitoneal areolar layer.

VARIETIES OF INGUINAL HERNIÆ.—Two principal forms of inguinal hernia are described, which are distinguished according to the part of the canal which they first enter, as well as by the position which they bear with respect to the epigastric artery. Thus, when the hernia takes the course of the inguinal canal from its commencement, it is named *oblique*, because of the direction of the canal, or *external*, from the position which its neck bears with respect to the epigastric artery. On the other hand, when the protruded part, without following the length of the canal, passes at once through its posterior wall at a point opposite the

Fig. 373.

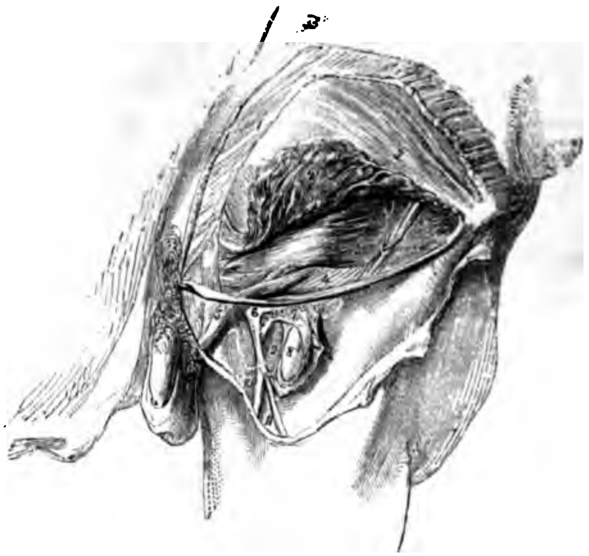


Fig. 373.—THE INGUINAL CANAL AND FEMORAL SHEATH FULLY EXPOSED. (R. Quain.)

The lower part of the external oblique has been removed (with the exception of Poupart's ligament), a portion of the internal oblique raised, and the transversalis muscle and fascia brought into view. The femoral artery and vein are seen to a small extent, the fascia lata having been turned aside and the sheath of blood-vessels laid open. 1, external oblique muscle; 2, internal oblique; 2′, part of same turned up; 3, transversalis muscle; upon the last-named muscle is seen a branch of the circumflex iliac artery, with its companion veins; 4, transversalis fascia; 5, spermatic cord covered by the infundibuliform fascia; 6, upper angle of the iliac part of the fascia lata; 7, femoral sheath; 8, femoral artery; 9, femoral vein; 10, saphenous vein; 11, a vein joining it.

external abdominal ring, the hernia is named, from its course, *direct*, or from its relation to the epigastric artery, *internal.*

**Oblique inguinal hernia.**—In the common form of this hernia the protruded viscus carries before it a covering of peritoneum (the *sac* of the hernia), derived from the outer fossa of that serous membrane (p. 701); and, in passing along the inguinal canal to the scrotum, it is successively invested by the coverings given to the spermatic cord from the abdominal parietes. The hernia and its sac lie directly in front of the vessels of the spermatic cord, and do not extend below the testis, even when the tumour is of large size.

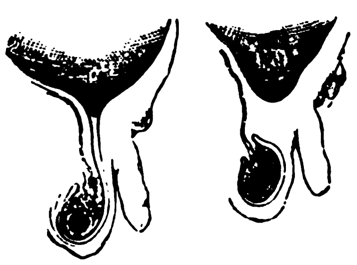
When the hernia does not extend beyond the inguinal canal, it is distinguished by the name *bubonocele:* and when it reaches the scrotum, it is commonly named from that circumstance *scrotal hernia.*

There are two other varieties of oblique inguinal hernia, in which the peculiarity depends on the condition of the process of peritoneum that accompanies the testis when this organ descends from the abdomen. In ordinary circumstances the part of the peritoneum connected immediately with the testis becomes separated after birth from the general cavity of that serous membrane by the obliteration of the intervening canal; and the hernial protrusion occurring after such obliteration has been completed, carries with it a distinct serous investment—the sac. But if this process of obliteration should not take place, and if a hernia should be formed, the protruded part is then received into the cavity of the tunica vaginalis testis, which serves in the place of its sac. In this case the hernia is named *congenital* (hernia tunicæ vaginalis,—Cooper). It is thus designated, because the condition necessary for its formation only exists normally about the time of birth; but the same kind of hernia is occasionally found to be first formed in the adult, obviously in consequence of the tunica vaginalis remaining unclosed, and still continuous with the peritoneum. The congitenal hernia, should it reach the scrotum, passes below the testis; and, this organ being embedded in the protruded viscus, a careful examination is necessary in order to detect its position. This peculiarity serves to distinguish the congenital from the ordinary form of the disease.

Fig. 374.—DIAGRAM OF A PART OF THE PERITONEUM AND THE TUNICA VAGINALIS TESTIS (after a sketch by Charles Bell).

In A, the serous investment of the testis is seen to be continuous with the peritoneum; in B, the two membranes are shown distinct from each other. 1, the peritoneal cavity; 2, the testis.

Fig. 374.



To the second variety of inguinal hernia, in which the distinguishing character depends on the state of the tunica vaginalis testis, the name *infantile* has been applied (Hey). The hernia in this case is covered with a distinct sac, which is again invested by the upper end of the tunica vaginalis. The relative position of the two serous membranes (the hernial sac and the tunica vaginalis) may be accounted for by supposing the hernia to descend when the process of the peritoneum, which accompanies the testis from the abdomen, has been merely closed at the upper end, but not obliterated for any length. Hence during an operation in such a case, the hernial sac is met with only after another serous bag (the tunica vaginalis testis) has been divided. The peculiarity here described has been repeatedly found present in the recently formed herniæ of grown persons. The term infantile, therefore, like congenital, has reference to the condition of certain parts, rather than to the period of life at which the disease is first formed.

*inguinal fossæ*. A little external to the obliterated hypogastric a
the epigastric artery gives rise to another less prominent elevation o
peritoneum, and an external hernia descends, as already explained, o
outer side of this artery, and therefore at the outer part of the ex
fossa. The more usual form of internal hernia, that which has
described above, descends in the internal fossa, between the oblit
hypogastric artery and the rectus muscle; while the less frequent
stretches the peritoneum of the inner part of the external fossa (
times described separately as the middle inguinal fossa) and e
between the hypogastric and epigastric arteries. Such a prot
passes through a considerable portion of the inguinal canal to rea
external ring, and has therefore a certain degree of obliquity, w
this variety is frequently termed *internal oblique inguinal hernia.*
also known as *superior internal hernia*, the direct form being call
*ferior internal*. An internal oblique hernia passes outside the con
tendon, and so has no covering derived from that structure,
receives one from the cremaster in the same way as an external he

Direct inguinal hernia is very rarely met with in the *female*.
single case observed by Richard Quain as well as in the few cases
recorded in books, the hernia though not inconsiderable in size w
covered by the tendon of the external oblique muscle.

### FEMORAL HERNIA.

A femoral hernia leaves the abdomen at the groin, passing b
Poupart's ligament, and over the anterior border of the hip-bone
diately at the inner side of the femoral vessels. It takes a dow
course through the innermost compartment of the femoral sheat

Fig. 378.

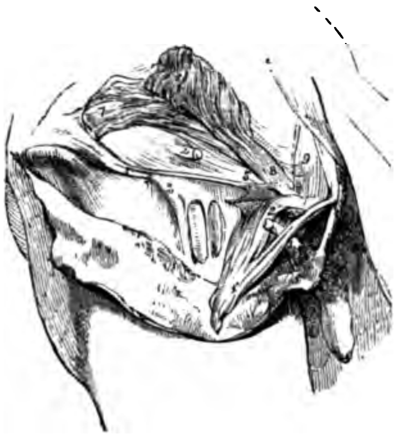


Fig. 378.—THE GROIN OF TH
SIDE DISSECTED SO AS TO
THE DEEP FEMORAL A
(Quain). ½

1, outer part of the femo
1′, part of the tendon of the
oblique muscle, with external
ring, projecting through
seen a portion of the spermat
cut; 2, femoral arch at its i
into the spine of the pubis,
the outer side the fibres of Gim
ligament; 3, outer part of the
sheath; 4, spermatic cord;
femoral arch—its inner end,
is fixed to the pubis; 6,
oblique muscle; 7, trans
below this the transversali
continued into the femoral
under the deep femoral arch;
joined tendon of the internal
and transversalis muscles;
angular fascia.

reaches the saphenous opening, when it turns forwards throu
opening towards the front of the thigh, and is then bent upwards
groin.

The *femoral* or *crural sheath* is a somewhat funnel-shaped str
surrounding the upper parts of the femoral artery and vein. It i

The coverings of a direct hernia, taking them in the order in which they are successively applied to the protruded viscus, are the following :—

Fig. 376.

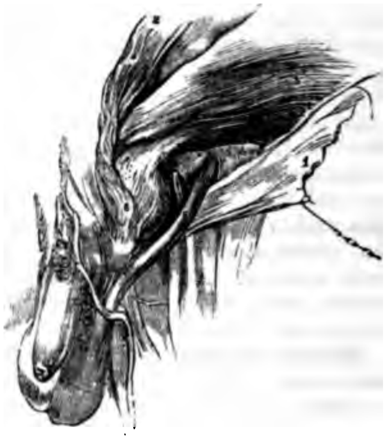


Fig. 376.—A DIRECT INGUINAL HERNIA ON THE LEFT SIDE, COVERED BY THE CONJOINED TENDON OF THE INTERNAL OBLIQUE AND TRANSVERSALIS MUSCLES (R. Quain).

1, aponeurosis of the external oblique; 2, internal oblique turned up; 3, transversalis muscle; 4, transversalis fascia; 5, spermatic cord; 6, the hernia. A small part of the epigastric artery is seen through an opening made in the transversalis fascia.

The peritoneal sac and the subperitoneal tissue which adheres to it, the transversalis fascia, the conjoined tendon of the internal oblique and transverse muscles, and the spermatic fascia derived from the margin of the external abdominal ring, together with the superficial fascia and skin. With regard to the conjoined tendon this hernia may be covered by it, or may pass through an opening in its fibres.

The spermatic cord is commonly placed behind the outer part of the hernia. The hernial sac is not, however, in contact with the vessels of the cord, the investments given from the transversalis fascia to those vessels and to the hernia respectively being interposed.

Fig. 377.

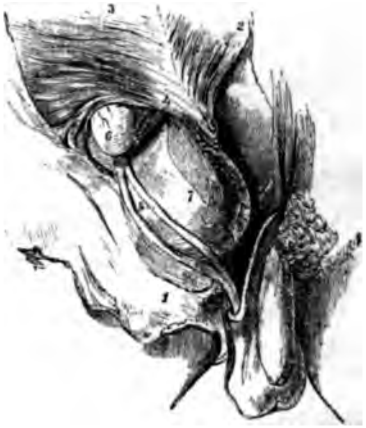


Fig. 377.—A SMALL OBLIQUE AND A DIRECT INGUINAL HERNIA, ON THE RIGHT SIDE (R. Quain).

1, tendon of the external oblique turned down; 2, internal oblique turned up; 3, transversalis; 4, on its tendon above a part of the epigastric artery, which has been exposed by dividing the transversalis fascia; 5, the spermatic cord (its vessels separated); 6, a bubonocele; 7, direct hernia, protruded at the conjoined tendon of the two deeper muscles, and covered by a prolongation of the transversalis fascia.

But the spot at which an internal inguinal hernia passes through the triangle of Hesselbach is subject to some variation, and there is a second form of internal hernia which differs somewhat in its course and connections from the foregoing. When the anterior abdominal wall is viewed from within (fig. 375), the obliterated hypogastric artery is seen running upwards to the umbilicus, and raising the peritoneum in a well-marked fold which separates two hollows known as the *external* and *internal* the fascia propria of the hernia (Cooper). It sometimes happens that the hernia is protruded through an opening in the sheath, which therefore in that event does not contribute to form the fascia propria. Lastly, the hernia is covered by the cribriform fascia stretching across the saphenous opening, the superficial fascia and the skin.

Fig. 379.

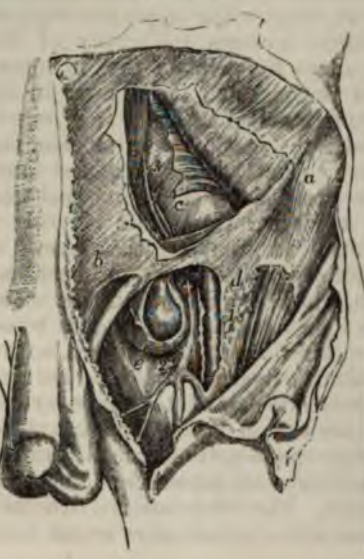


Fig. 379.—View of the relations of the vessels of the groin to a femoral hernia (R. Quain). ½

In the upper part of the figure a portion of the flat muscles of the abdomen has been removed, displaying in part the transversalis fascia and peritoneal lining of the abdomen; in the lower, the fascia lata of the thigh is in part removed and the sheath of the femoral vessels opened: the sac of the hernial tumour has also been opened.

*a*, anterior superior spinous process of the ilium; *b*, aponeurosis of the external oblique muscle above the external inguinal aperture; *c*, the abdominal peritoneum and fascia transversalis; *d*, iliac portion of the fascia lata near the saphenous opening; *e*, sac of the femoral hernia; 1, femoral artery; 2, femoral vein at the place where it is joined by the saphenous vein; 3, epigastric artery and vein; ×, placed upon the upper part of the femoral vein, close below the common trunk of the epigastric and an aberrant obturator artery; the latter artery is seen in this case to pass close to the vein and between it and the neck of the hernial tumour.

## THE PERINEUM OF THE MALE.

The perineum is the region which is included within the outlet of the pelvis, and which is traversed by the lower end of the rectum and by the urethra. It extends, therefore, from the apex of the subpubic arch in front to the tip of the coccyx behind, and from the ischial tuberosity of one side to that of the other. It is bounded on each side, at the fore part, by the conjoined rami of the pubis and ischium, and at the back part, by the great sacro-sciatic ligament together with a portion of the lower border of the gluteus maximus muscle. Its form is rather heart-shaped in consequence of the projection of the coccyx posteriorly; it measures about three and a half inches from side to side, and about four inches over the curved surface (three and a quarter inches in a straight line) from before back in the middle line. The perineal space is separated from the pelvic cavity above by the recto-vesical fascia and the levatores ani muscles; its depth is considerable (from two to three inches) at the posterior and outer part, much less (not exceeding an inch) at the fore part.

The perineal space is conveniently divided into two parts by a line drawn across from one ischial tuberosity to the other, and passing immediately in front of the anus. The anterior division is termed the *urethral part,* and is often referred to as the true perineum ; the posterior division is called the *anal part* or the false perineum.

The several muscles and fasciæ, vessels and nerves, which enter into the formation of the perineum have been fully described in the earlier chapters of this volume, and it now only remains to give a short sketch of its superficial and topographical anatomy, with which may be included also the relations of the adjoining parts of the pelvic viscera.

**Superficial anatomy.**—The osseous portions of the boundaries of the perineum can be felt more or less distinctly through the skin, but the anterior portion of the subpubic arch is obscured by the presence of the penis, and the ischial tuberosities are at some distance from the surface, being covered by a thick layer of fat and, in the erect position, also by the great gluteal muscles. The sacro-sciatic ligament is scarcely to be distinguished beneath the gluteus maximus, except in very thin subjects. The lower part of the coccyx is very plainly felt. The anus is placed directly between the ischial tuberosities, its centre being about one inch and a half from the extremity of the coccyx.

The skin of the perineum is thin and provided with more or less abundant hairs ; it is gathered into puckered folds round the anus, to which a farther irregularity is often given by swollen hæmorrhoidal veins. In front of the anus is a median ridge, the *raphé*, which runs forwards and is continued on to the scrotum and penis. Beneath this, the bulb of the urethra forms a slight median elevation, more perceptible in emaciated subjects. In such subjects again, the fat in the ischio-rectal fossa does not reach the level of the ischial tuberosities so as to form a rounded surface sinking in towards the anus, as is the case in those who are well nourished. A fine white line round the anus indicates the point of junction of the skin and mucous membrane, and corresponds precisely to the division between the external and internal sphincters (Hilton).

One inch in front of the anus is situated the central point of the perineum, which corresponds to the centre of the free border of the triangular ligament. Immediately in front of this, the bulb of the urethra commences, but the membranous part perforates the triangular ligament about half an inch farther forwards, and therefore one inch and a half in front of the anus.

**Topographical anatomy.**—The superficial fascia of the perineum consists of two layers, the more superficial of which is the ordinary subcutaneous fascia and contains fat, especially in the posterior portion of the space, where it is very abundant and fills the ischio-rectal fossa. The deeper layer or fascia of Colles, is membranous, and is confined to the anterior part of the space ; it is attached on each side to the rami of the ischium and pubis, and posteriorly to the base of the triangular ligament ; it thus forms a somewhat triangular pouch in the fore part of the perineum, which may modify the course of an extravasation of urine or a collection of pus in this situation. The pouch is, moreover, subdivided posteriorly by a median septum which extends from the back of the perineum to the scrotum.

The hinder part of the perineum is occupied in the centre by the lower end of the rectum, and between this and the ischial tuberosity on each side is a considerable hollow known as the ischio-rectal fossa.

The **ischio-rectal fossa** is a hollow of an irregularly pyramidal shape. Its base is turned downwards, and measures about two inches from before back, and one inch from side to side. Its outer wall is perpendicular, and is formed by the obturator internus muscle covered by its fascia below the level at which the recto-vesical fascia is attached to it. The inner wall is oblique in direction and convex towards the fossa; it is formed by the levator ani muscle, covered by the thin anal fascia, and at the lower part by the external sphincter. Anteriorly, the fossa is limited by the base of the triangular ligament, and posteriorly, by the gluteus maximus muscle and the great sacro-sciatic ligament. Its depth is about two inches (above the margin of the tuberosity) at the hinder part, where it extends upwards to the ischial spine, the small sacro-sciatic ligament and the coccygeus muscle.

The pudic vessels and the dorsal and perineal divisions of the pudic nerve run forwards along the outer wall of the fossa, being embedded in the obturator fascia about an inch and a half above the lower margin of the ischial tuberosity; the inferior hæmorrhoidal branches of these trunks run obliquely inwards and forwards from the hinder part of the fossa towards the anus; and anteriorly, the superficial perineal vessels and the perineal nerve leave the shelter of the hip-bone and also enter the fat of the fossa.

The ischio-rectal fossa is often the seat of abscesses which burrow freely in the loose fat of the part, and frequently result in the formation of a fistula in ano, involving a communication with the bowel, sometimes above, but more frequently below, the external sphincter.

The lower dilated part of the rectum, which occupies the space between the two ischio-rectal fossæ, is supported by the levatores ani and the external sphincter muscles, as well as by the recto-vesical fascia. Its lateral wall is exposed for a distance of about three inches, its posterior wall for little more than an inch.

On removing the fasciæ of the fore part of the perineum the bulbo-cavernosus muscle is exposed covering the corpus spongiosum, the ischio-cavernosus covering the crus penis, and the transversus perinei directed inwards over the base of the triangular ligament to meet the first-named muscle, as well as the external sphincter and its fellow of the opposite side, in the central point of the perineum. Between the bulbo-cavernosus, ischio-cavernosus, and transversus muscles is a small triangular space, in which a portion of the triangular ligament is exposed, and over the surface of the muscles (sometimes in part beneath or through the transversus) the superficial perineal vessels and nerves run forwards to the scrotum, while the small transverse perineal artery is directed inwards close to the transverse muscle towards the central point of the perineum.

The triangular ligament or deep perineal fascia, which occupies the subpubic arch, has a depth of an inch and a half in the middle line, but extends somewhat farther backwards on each side, at its attachment to the ischial ramus. It consists of two layers, the upper of which is continuous with the recto-vesical fascia. The membranous part of the urethra descends, first through the superior, and then through the inferior layer, about an inch from the symphysis pubis, and it is surrounded by the fibres of the constrictor urethræ muscle, which occupies the greater part of the space between the two layers. Near the urethra, also embedded in the muscular fibres, is Cowper's gland. The pudic vessels and the dorsal nerve of the penis enter the base of the triangular ligament and run forwards close to the bone, in small canals formed in the origin of the constrictor muscle, and the artery gives off here its com-siderable branch to the bulb, which is directed inwards about half an inch from the base of the triangular ligament, and an inch and a half in front of the anus.

Resting on the upper surface of the triangular ligament is the apex of the prostate, and this body is surrounded by its sheath, which is continuous on each side with the upper layer of the ligament; beneath the sheath is the large prostatic plexus of veins, derived mainly from the breaking up of the dorsal vein of the penis which passes into the pelvis between the symphysis pubis and the triangular ligament. In the recess between the lateral part of the upper surface of the triangular ligament and the sheath of the prostate, the anterior part of the levator ani muscle is lodged.

Above the prostate, and at a depth generally of from two and a half to three inches from the surface, is the bladder, the base of which projects backwards into the concavity formed by the rectum and overlaps the second part of the bowel to a variable extent according to the degree of distension of the bladder. Between the bladder and rectum are the vesiculæ seminales and the terminal portions of the vasa deferentia. When the bladder is full, the recto-vesical pouch of the peritoneum does not usually reach below a line an inch and a half from the base of the prostate.

In contact with the upper surface of the levator ani is the recto-vesical fascia, forming the deep boundary of the perineal space. It extends from the side wall of the pelvis downwards and inwards to the side of the rectum, to the bladder and prostate. Its line of attachment to the bladder on each side runs upwards and backwards immediately above the prostate, and external to the position of the vesiculæ seminales; and it is essential, in the operation of lithotomy, that the bladder be opened entirely below this level. If the incision be carried through the fascia beyond this line, then the pelvic cavity will be opened, and extravasation of urine into the loose areolar tissue will probably follow.

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ARTERIES (ἀρτηρία, from ἀρτ[illegible] which anything is suspe[illegible] ginally applied to th[illegible] by which the lungs [illegible] to be suspended, τραχε[illegible] [illegible] afterwa[illegible] arteries, at one time [illegible] like the windpipe, to [illegible] Another less probabl[illegible] is from ἀήρ, air; τηρε[illegible] Descriptive Anatomy o[illegible] size and classification of,
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